DOCUMENT RESUME

ED 160 458 SE 025 131

TITLE How to Identify and Control Water Weeds and Algae.
INSTITUTION Applied Biochemists, Inc., Mequon, Wis.
PUB DATE 76
NOTE 66p.; Not available in hard copy due to copyright restrictions; Colored photographs will not reproduce well
AVAILABLE FROM Brown Deer Chemical Co., P.O. Box 23403, Brown Deer, Wisconsin 53223 ($3.95 ea; $2.95 ea. for 12 or more)

EDRS PRICE MF-$0.83 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS Agriculture; *Botany; Environment; *Herbicides; *Instructional Materials; Pesticides; *Postsecondary Education; Sciences; Water Pollution Control; *Water Resources; *Weeds
IDENTIFIERS *Algae

ABSTRACT

Included in this guide to water management are general descriptions of algae, toxic algae, weed problems in lakes, ponds, and canals, and general discussions of mechanical, biological and chemical control methods. In addition, pictures, descriptions, and recommended control methods are given for algae, 6 types of floating weeds, 18 types of submerged weeds, and 4 types of emergent weeds. (BB)

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HOW TO IDENTIFY AND CONTROL

WATER WEEDS AND ALGAE

ED160458

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A GUIDE TO WATER MANAGEMENT

How to Identify and Control

WATER WEEDS and ALGAE

Library of Congress No. 76-3294

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Applied Biochemists, Inc. is dedicated to promoting sound water management. It is our intention to enhance and preserve the recreational, aesthetic, and economic value of the world's water resources. This book is an educational step toward that goal.

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INTRODUCTION

With rapidly increasing pollution, water is becoming one of our most valuable natural resources. Land adjacent to natural waters is steadily increasing in value. **Realtors** and land developers have discovered the lure of water by building homes around artificial lakes. Clear, sparkling waters for swimming, fishing and water sports are prized objectives of the recreation industry. **Campgrounds, fishing** and **hunting clubs, resorts** and **motels** all thrive on clean, inviting saleable waters.

Municipalities and **sanitary districts,** in addition to other water problems, face the same problems and search for solutions.

Industrial waters and **fire ponds** are especially susceptible to weed and algae growth.

Irrigation districts are constantly plagued by heavy weed and algae infestations that impede their operations and raise costs.

Property owners located on lakes with deteriorating water quality watch in dismay as excessive weeds and algae choke their waters and reduce property values. This problem is common and widespread in lake communities. Water tables are receding in many areas. It is quite possible that water, in the near future, could become prohibitively expensive.

Property owners, whether located near water or not, are accustomed to maintaining their properties for aesthetic reasons: pride of ownership and retention of property values. In the same manner, lake property owners should maintain their water with yearly aquatic nuisance control methods.

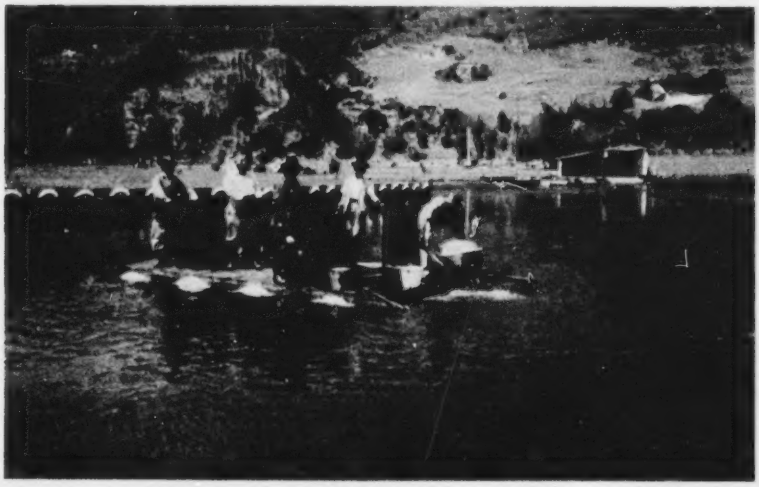
A program of water management is a definite must for all adjacent property owners. This book will help in planning such a program.

Lake on cover before weed control.

THE DOMOGALLA STORY

One of the first to recognize and begin the battle against the effects of water pollution was the late Dr. Bernard P. Domogalla, an aquatic biologist and founder of Applied Biochemists, Inc. As one of the country's pioneer aquatic pesticide applicators, he was well aware of the problems caused by excessive weeds and algae.

Chemical treatment of water to eliminate weeds and algae was initiated by Dr. Domogalla while in charge of the Wisconsin State Laboratory of Hygiene in the 1920's. During his active business life of over 40 years, he was responsible for the development of many formulations for the control of aquatic weeds and algae. His original working area was the chain of lakes around Madison during his public service. Thereafter, as a private consultant, his work also extended into South America and Europe.



Dr. Bernard P. Domogalla [second from left] is shown applying Cutrine on Lake Muna in Colombia, South America - 1958.

Domogalla, a dedicated conservationist, specialized in control of the ever-present algae that covered lakes, ponds, lagoons and all types of waters. Copper sulfate was the accepted algaecide of that time. He knew that fish were being adversely affected by the copper precipitate resulting from its use. These insoluble carbonates built up in a layer on the bottom of lakes and ponds to eventually disrupt the fish food chain and inhibit necessary weed growth. Actually, because of its quick precipitation, copper sulfate has only a short contact (killing) time and leaves no active material to prevent the algae from rapidly returning. Hence, large quantities and repeated applications are necessary.

Faced with these undesirable side effects, Domogalla spent many years searching for a better algaecide. Hundreds of formulations were tested without success. At last he realized that copper was really the only natural, economical agent for killing the algae cell. However, the elemental copper needed to be "harnessed".

After months of trial and error, he finally "chelated" (chemically locked-in) the copper with triethanolamine and halted its quick precipitation.

Finally the destructive effects of copper sulfate had been reduced and the first step in producing a new, improved algaecide was taken. He names "CUTRINE" ("CU" for copper and "TRINE" for the "tri" in triethanolamine) and set about having it patented. Today CUTRINE is rapidly supplanting copper sulfate in the knowledgeable water management community.

CURRENT DEVELOPMENTS

Since Dr. Domogalla's retirement in 1964 and death in 1969, Applied Biochemists, Inc. has maintained a continuing research program dedicated to improving CUTRINE. This has produced improvement patents in 1970, 1972 and in 1976 a new patent was granted for CUTRINE-PLUS which now eliminates sulfates entirely for far less corrosion in use.

This research and development is an on-going program resulting in direct benefits from new, more effective products for water management.

Spraying long irrigation canals with CUTRINE-PLUS by helicopter.

IDENTIFYING THE PROBLEM

Aquatic vegetation is found in most lakes and ponds and is beneficial to the natural ecosystem. It provides food and cover for aquatic organisms, produces oxygen and stabilizes bottom sediments.

Aquatic plants are often referred to as "weeds." This is improper terminology as the definition of a "weed" is "any undesired plant that grows so profusely as to crowd out more desirable plants or detracts in some way from the usefulness and/or appearance of an area." Unfortunately, many ponds and lakes develop overabundant aquatic vegetation which interferes with recreational activities, destroys aesthetic values, and adversely affects aquatic life. This, then, is a "weed" problem.

All plants require nutrients and sunlight for growth. The depth of sunlight penetration limits the depth to which plants can grow. At the same time, the amount of nutrients available, basically nitrogen and phosphate, will limit the quantity of vegetation which can grow.

Unfortunately, nutrient enrichment of water bodies, a process known as eutrophication, is enhanced by man's agricultural, industrial and domestic activities. Nutrient sources include cropland and feedlot runoff, factory and cannery effluents, detergent wastes, sewage disposal discharge, septic tank seepage, fertilizer runoff from lawns and gardens, etc. All these sources add to the water's fertility and can result in excessive plant growth and toxic conditions.

Nuisance aquatic vegetation can be divided into the two general categories: "algae" and "weeds," based on differences in biological structures and processes (morphology and physiology).

Filamentous Algae Mats.

ALGAE PROBLEMS

Excessive algae growth can destroy the appearance of water as well as interfere with its intended uses. These problems confront both those who want to maintain waters for recreational purposes and those who are responsible for managing large supply reservoirs used for irrigation and human consumption. Specific problems occurring at various use sites are discussed in each of the sections below.

MUNICIPAL WATER TREATMENT

Surface waters used for public drinking water supplies often become contaminated with algae. Problems associated with these growths include discoloration, unpleasant tastes, foul odors and clogged filters. Algae in tap water can stain porcelain wash and toilet basins. Unpalatable algae have reportedly imparted flavors to water ranging from sweet to bitter. A variety of odors, described as fishy, grassy, septic, musty, garlic and spicy, have been attributed to algae. Algae growing on or accumulating in sand filters used in water treatment can shorten filter runs considerably, thus necessitating more backwashes and reducing the efficiency of the water treatment plant considerably.

Algae play an important role in sewage treatment stabilization ponds and trickling filters. Balanced algal and aerobic bacterial populations must be maintained to assure proper functioning of the system. Infestation of unwanted algal species or overpopulation of algae may clog filters or contribute to already high solid content and Biochemical Oxygen Demand in ponds. This could result in anaerobic conditions and treated wastewater not meeting effluent standards.

IRRIGATION WATERS

Efficient movement of water in irrigation systems, critical in many areas of the country, can be impaired by algae clogging control gates, distribution lines, water intakes, sprinkler heads and other associated equipment. Severe growths can stagnate water, resulting in warmer water temperatures, compounded weed and algae growth, silt deposition, higher water levels, increased evaporation and seepage.

GOLF COURSE WATERS

Shallow water hazards and scenic lagoons located on well-fertilized greens and fairways are prime targets for noxious algae growth. Lost golf balls in thick surface algae mats or in opaque, green waters represent a financial loss to disgruntled golfers and slows play. Foul odors emitted from decaying, unsightly algae can detract from the beauty of a course and the pleasures of the game. In addition, sprinkler irrigation systems hooked up to these ponds often become clogged and inoperative.

FISH PONDS

Excessive algae growth in fish-producing waters can create a variety of problems for the fisherman and the fish farmer. Besides snagging fishing lines and interfering with commercial harvest methods, algae can taint the flavor of fish flesh. Some fish diseases and parasitic infections have been indirectly associated with algal growth. Reduced oxygen production or die-off and decomposition of large algae populations during prolonged periods of cloudy weather or under snow-covered ice can critically deplete dissolved oxygen concentrations, causing summerkill or winterkill of fish. In trout raceways, stagnation of water due to algae blockage can result in warmer water temperatures with lower dissolved oxygen concentration. Stressed fish are more prone to disease.

Floating Algae Mats

SWIMMING PONDS AND BEACH AREAS

Swimming in algae-infested waters is not a pleasant experience. Taste and odor problems associated with algae become even more evident when one is in the water. Algae-covered rocks, ladders and rafts become slippery and hazardous. Algal mats harbor mosquito larvae and other insect pests which interfere with recreational activities around water bodies.

LAKE FRONTS

Shoreline areas in front of cottages can become unsightly and uninviting as a result of excessive algae growth. Intake pipes to lawn and garden irrigation systems become clogged and inoperative. Peeling paint and staining on boats, docks and other objects exposed to the water are partially the result of algae growth. Some species actually produce acids which chemically corrode submersed metal pipes and concrete structures.

TOXIC ALGAE

Death and sickness to pets, livestock, wildlife and even man have been attributed to the presence of certain algae, mostly blue-green bloom-forming species, in water supplies. Lethal substances produced by these algae are retained within the cell and released after death (endotoxin) or are secreted from living cells (exotoxin). Much is still left to be learned about the nature and origin of these substances. It is important that water purification engineers, livestock raisers, wildlife specialists, pond owners and lake property owners are aware of this potential danger. Many unattended farm ponds and other waters contain some of these toxic forms, posing a threat to human health and environment. Medical case histories, biologist reports and laboratory tests show some of the possible effects of toxic algae.

Planktonic ["Pea Soup"] Algae.

HUMANS: A list compiled by the U.S. Department of the Interior Federal Water Pollution Control Administration summarizes medical case histories of algae poisonings from 1842 through 1961. Exposure to and ingestion of algae caused a variety of discomforts including: skin rashes, headaches, nausea, vomiting, diarrhea, fever, eye, nose and throat irritation and muscular pains.

WILDLIFE: Severe ecological disruptions attributed to overabundant toxic algal species have been reported. For example, an Iowa State Biologist reporting on a 1948 algae bloom on Storm Lake recorded the loss of thousands of Franklin gulls, migratory waterfowl and fish.

LIVESTOCK: The California State Water Resources Control Board states in their Water Quality Criteria Handbook (Second Edition): "From many different parts of the world, including the United States, there have been reports of rapid deaths of a great variety of animals after drinking water containing high concentrations of blue-green algae such as **Anacystis, Aphanizomenon, Nostoc rivulare, Nodularia, Gleotrichia, Gomphosphaeria** and **Anabaena**. Fatal poisonings have occurred among cattle, pigs, sheep, dogs, horses, turkeys, ducks, geese and chickens, and also among experimental animals such as rabbits, rats, guinea pigs and mice. It is believed that such algae may be toxic to all warm-blooded animals."

WEED PROBLEMS

Aquatic plants (vascular) can be distinguished from algae by the presence of true leaves, stems and root systems. They reproduce by means of seeds, buds or fragmentation. These plants are adapted to a variety of conditions. Water clarity, depth and the type of bottom sediment usually determines the type of weeds which can grow in a specific area.

Weeds can create the following problems:

1. Fouled outboard motor props
2. Snagged fish lines
3. Difficult or even dangerous swimming
4. Stunted fish
5. Siltation and sedimentation
6. Fish kill
7. Blocked drainage or irrigation ditches

We have divided weeds into three main categories: **floating** (both free-floating and floating leaf), **submergent** and **emergent.** Deeper water contains **submergent** weeds; underwater plants usually rooted to the bottom and often growing up to the water surface. In shallow waters, rooted **floating-leaf** plants are commonly found with underwater rooted stems and a leaf or leaves floating parallel to the water surface. Sometimes the surface of a body of water is inhabited by free-floating plants which do not root on the bottom or else have been uprooted. On or near shore and in shallow water areas, **emergent** vegetation usually dominates. These plants have their leaves and or stems extending above the water surface. Weed identification illustrations begin on page 27.

NOTE: The aquatic weeds discussed in this book represent the major nuisance species found throughout the world. By no means, however, do they include all weeds found in water.

TREATING THE PROBLEM

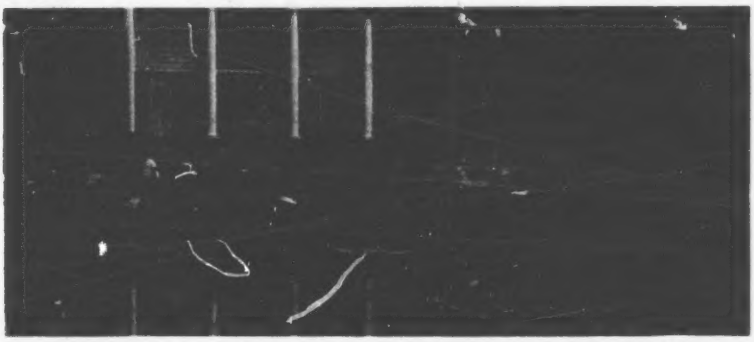
Waters clogged with aquatic vegetation are usually rendered useless for their intended purposes. Correctional methods are available, but before choosing a technique, consider the following interrelated factors:

1. **What is the intended use of the water?**
   It is usually not necessary to **eliminate** all the growth, but rather to **control** vegetation creating a nuisance. The degree of weed and algae control is determined by water use.
2. **How safe is the method?**
   This should not only include human hazards, but also the environmental hazards. Seemingly harmless alterations in the aquatic environment can sometimes result in irreversible ecological damage.
3. **How effective is the method?**
   The various control methods offer varying degrees of effectiveness. Desirable objectives are long-lasting control and minimizing time and effort expenditure.
4. **What method is least costly?**
   This question must be judged on a long-term basis. Capital investment and labor must be included in these costs. Safety and effectiveness are also cost factors to consider.

The following methods have been used as aquatic nuisance control techniques. The advantages and disadvantages of each are discussed.

MECHANICAL REMOVAL

Various physical methods can be used to remove plant material from lakes and ponds. Techniques include pulling, raking, digging, skimming, cutting, lining, shading, draining, dredging, etc. Equipment costs can range from practically nothing to an investment of thousands of dollars.



Hand removal techniques are time-consuming and hard work. Simply picking the stems and flowers of plants will not reduce their populations since many aquatic weeds have well-established underground root and stem systems. Working underwater to remove these is a cumbersome task.

Weedcutter. Photo courtesy Aquamarine Corp., Waukesha, Wis.

Mechanical weed cutting equipment ranges in size from portable cutting bars to intricate weed harvesters resembling combines, including such associated equipment as transport barges, unloaders and balers. Operations have been established, utilizing heavy equipment on large bodies of water. This is often not feasible in smaller lakes and ponds.

Pulling or cutting weeds is not effective if it is not combined with harvesting. Many cut weeds re-establish themselves from fragments. This compounds existing problems by dispersing them into new areas. Removal of cut weeds reduces the nutrient and sediment load from decaying vegetation. In addition, results are immediate and involve no closing of the water as in chemical control.

Problems associated with weed cutting and harvesting include: high cost, short-term control, limited mobility and ecological disruption. In addition to capital expenditures, costs of maintenance and storage should be considered. Labor costs are higher because, like mowing a lawn, weeds will need frequent cutting during the season. Cumbersome cutters do not allow mobility around docks and close to shore where most recreational activities take place. Powerful cutting bars and conveyors disturb bottom sediments and create temporary turbid conditions. Ecological disruption may occur if cutting is done in fish spawning areas. Widespread cutting often reduces stands of more beneficial plants along with nuisance growths and leaves a heavy weed growth six feet below the water surface.

Weed harvesters cannot remove most forms of algae. Attempts have been made at removing floating mats of algae and surface plants by dragging a plank across the water surface. Although useful in very small areas, it will offer only temporary relief.

Plastic liners have been used for controlling weed growth. Lining a pond bottom with plastic and covering it with pea gravel or sand prevents rooted plant growth. The cost of these materials usually makes it practical only in ponds or beach areas. It cannot be used in bodies of water with steep shoreline drop-offs. Generally, this technique will not significantly reduce algae populations if nutrients are already available in the water.

Shading bottom growth with black plastic sheeting or chemical dyes has been an attempted method of control. Sheeting makes the water inaccessible, usually for several weeks. Dyes last only temporarily, are not effective against surface growth, and are costly to use on a maintenence basis.

Water drawdown (lowering water levels where possible) is an effective tool in reducing aquatic weeds, especially in freezing climates. Root systems of several types of plants such as milfoil can be destroyed if the ground freezes. Other submerged plants will be killed by drying out. Unfortunately, emergent shoreline plants often replace submerged weeds, thus creating new problems. Shallow water fish habitats can be destroyed if levels are lowered in spring or summer.

Dredging is the ultimate form of pond renovation since it removes both existing plants and their root structures at the same time the water body is deepened. Deepening and maintaining proper shoreline slope is an effective rooted-weed prevention method. Problems associated with dredging include expense, disposal of spoils and total disruption of the existing environment.

BIOLOGICAL CONTROLS

Recently, much research has gone into finding safe and effective natural methods for controlling weeds and algae. Although some methods have shown promise, most involve the introduction of exotic organisms with unknown long-term ecological consequences.

Fertilization of ponds to produce planktonic algae blooms which shade out rooted vegetation and increase fish production has been successful in the South. Blooms of this type, however, often overdevelop in the North and the added nutrients will stimulate more weed growth. Planktonic blooms also detract from recreational and aesthetic values. There is also the potential for infestation by very noxious algal species, causing taste and odor problems.

The White Amur (Ctenopharyngodon idella) and fish of the genus Tilapia, have been introduced experimentally as aquatic herbivores (weed and algae eaters). Unfortunately, they have escaped into major river systems before their reproductive potentials, competitiveness and habits have been thoroughly studied.

A large crayfish species, **Orcanectes causeyi,** feeds on living and dead plant material. It has become a nuisance to swimmers because of its size and "voracious appetite."

Various other organisms have been tested and introduced to a limited extent for control of specific pests. **The lily weevil,** an insect, is being used in some areas of the South to control water hyacinth. **Manatees,** large aquatic mammals, are effective aquatic herbivores; however, their habitat is limited to tropical areas. A variety of plant diseases and viruses are also currently being tested and may have value as future aquatic nuisance control techniques.

Note: State and Federal regulations prohibit the transportation and introduction of exotic organisms discussed above in many areas of the country. Consult your local authorities.

Chemical spraying - Photo courtesy MARINE BIOCHEMISTS, INC.

CHEMICAL METHODS

The use of chemicals is the most common and effective method for controlling nuisance weed and algae growths. Chemicals offer longer-lasting control than mechanical methods, involve less physical labor and ultimately cost less. Years of research in testing chemical effectiveness, toxicity and residues has "weeded" out questionable, hazardous materials. Now, only a limited number of highly effective, approved products remain in use. Certain chemicals and application rates selectively control only target weed species; hence, the applicator has the option of treating only specific nuisance weeds. Applications can be made in areas that can't be reached by other methods. Water under piers and docks can be treated easily.

There are a few drawbacks to chemical control methods. Some chemicals close the water to swimming, fish consumption, irrigation and drinking for varying periods of time. An algaecide, such as CUTRINE-PLUS, on the other hand, does not close the water. It can be used immediately for any purpose. Care must be taken in handling and application of some of the more hazardous materials. Permits and official supervision are required for applying aquatic pesticides in some states. Varying water and weather conditions may interfere with the effectiveness of a given herbicide or pesticide (see **PRECAUTIONS**, page 19).

Aquatic pesticides are generally divided up into the two classifications—algaecides and herbicides. **Algaecides are used for controlling algae, whereas herbicides control weed growth.** These products come in either liquid, granular or powder formulations. They kill aquatic plants either by direct contact (contact-killers) or uptake by leaves, stems or roots (systemic).

Before treating:

1. Identify the problem weeds and/or algae (see pages 23-57).
2. Choose the proper chemical(s) and read the label carefully, noting all precautions. (See page 19.)
3. Determine the size of the area to be treated (see page 18).
4. Choose suitable application equipment (see page 16).
5. Dilute the chemical if specified on the label. Mix only as much chemical as is needed for the job.

While treating:

1. Apply recommended amount of chemical uniformly over the area to be treated.
2. Avoid drift—set sprayer for coarse spray—keep the application within the intended treatment area. Do not treat on windy days.
3. Treat from the shoreline outward toward the center of the water body to avoid trapping fish and other organisms in bays or inlets.
4. In heavily infested, smaller bodies of water, treat only 1/3 to 1/2 of the area at a time—allowing 1 to 2 weeks between successive treatments.
5. Do not eat, drink or smoke while applying pesticides and avoid contact with skin, eyes and clothing.

After treatment:

1. Clean up application equipment, wash up and change clothes.
2. Post areas with signs or notify residents if the water is to be closed for any of its uses.
3. Do not reuse empty containers.

When to treat:

The best time to treat will vary from state to state. Generally, chemical applications are most effective when weeds are growing rapidly and have not yet gone to seed. Seeds are not killed by the action of herbicides. The number of treatments necessary will be based on the length of the growing season. One or two herbicide treatments are usually sufficient for seasonal control whereas 3 to 4 algaecide treatments may be required. Chemicals should not be applied in strong winds where drift might occur. For best results, chemicals should be applied early in the day under sunny conditions and when water temperature is above 60°F. Biological and chemical activity may be reduced under colder water or cloudy weather conditions. Check the product labels for information regarding this. Regrowth or belated appearance of dormant weed species will require re-treatment.

EQUIPMENT

The type of formulation chosen and the size and nature of the treatment area will determine the most efficient application equipment to use.

Hand-application of chemical is effective in small bodies of water (one acre or less) and for shoreline applications. Granular material can be sprinkled into the water around docks, piers and shorelines. Diluted liquid formulations can be poured directly into the water in the wake of a boat or applied with a sprinkling can around infested areas.

Simple granular application - Photo courtesy MARINE BIOCHEMISTS, INC.

Mechanical equipment is more efficient for larger jobs. Hand-powered fertilizer or seed spreaders work well for broadcasting granular material from the shoreline or a boat. Three to five gallon pressure tank sprayers are useful for treating small patches of weeds and algae, especially emergent shoreline vegetation. When using wettable powders, it is necessary to keep the solution agitated. Boat bailers can be adapted to injecting chemical directly into the water.

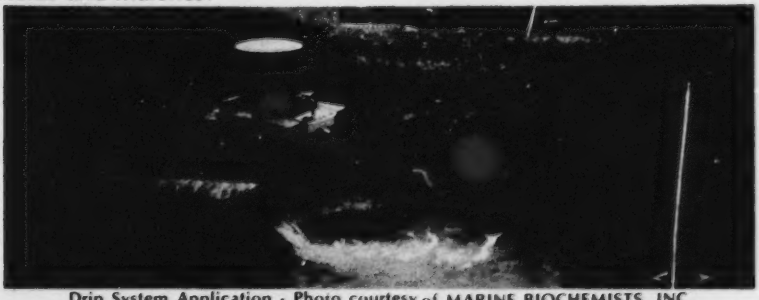
Backpack Spray Application - Photo courtesy of MARINE BIOCHEMISTS, INC.

Power Spray Application - Photo courtesy of MARINE BIOCHEMISTS, INC.

Power-operated equipment can be rented or purchased for large treatment areas. Battery operated granular fertilizer spreaders and hoppers can be mounted onto the boat to facilitate extensive granular applications. A variety of small horsepower centrifugal and siphon pumps can be adapted to chemical applications. This will usually involve a chemical intake and/or water intake and a spray hose equipped with a nozzle. Pumps with a "Y" connection on the intake side are suited for using undiluted chemical as water from the lake mixes with chemical inside the pump. Mixing can then be controlled with a valve. A simpler set-up with only one intake is useful when using diluted chemical.

Spray should be adjusted to coarse droplets to minimize drift. Underwater applications can be made from a boat by dragging the application hose beneath the water or a series of these hoses can be set up in a boom arrangement. Gasoline-operated, portable tank sprayers can be used around shoreline areas difficult to reach by boat.

Very large bodies of water may require large equipment. Helicopter and airplane applications are used on long drainage canals, ricefields and marshes.



Drip System Application - Photo courtesy of MARINE BIOCHEMISTS, INC.

Some situations may require specialized application equipment. **Chemical drip systems** are useful in weed and algae-infested flowing and irrigation waters. They deliver chemical at a uniform rate based on water flow.

Inverting, a method of combining oil droplets and chemical involves specialized mixing and application equipment. This technique is used by commercial applicators in the Southern States.

DETERMINING AREA TO TREAT

Most aquatic algaecide and herbicide labels give their application rates in terms of amount to apply per acre or acre-foot of water. It is, therefore, important to know how to calculate these measurements. An acre is a two dimensional surface area measurement of 43,560 square feet. An acre-foot is an acre of water 1' deep.

Fig. 1

Fig. 2

On small bodies of water, acreage can be determined by multiplying average length (in feet) times average width (in feet) and dividing by 43,560. Use the conversion chart on page 62 for instant calculations.

For large bodies of water, maps specifying acreage figures, shoreline length and average depth may be available from state agencies, Soil Conservation Service or real estate developers. Consult these sources before pursuing the task of measuring them yourself.

To determine acre feet, multiply the acreage by average depth (in feet). In bodies of water having a uniform bottom slope, average depth can be approximated by dividing the maximum depth made by two (see Figure 1.). More accurate determinations (Figure 2.) can be made by taking a series of measurements at uniformly spaced points along the length and width of the water body. Total the measurement figures and divide by the number taken.

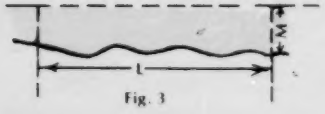


Fig. 3

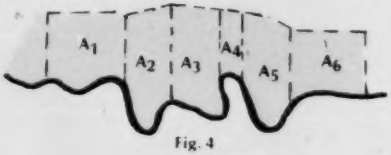


Fig. 4

Where only shoreline treatments are required (for example, a 20 acre lake may only need 5 acres of shoreline treatment), it is necessary to measure shoreline length. Along relatively straight shorelines, multiply shoreline length (in feet) times the width (in feet) of the treatment area (see Figure 3.). Along irregular shorelines, it may be necessary to divide the treatment area into rectangular sections, determine the acreage of each and add them together to get the total acreage (see Figure 4.).

PRECAUTIONS

Safety and effectiveness go hand in hand when using pesticides. These guidelines are as much a part of the directions as are application rates and techniques. FOLLOW THEM CAREFULLY!

READ THE LABEL CAREFULLY!

Handling

- Avoid contact with skin, eyes and clothing.
- Avoid prolonged breathing of vapors.
- Do not take internally.
- Do not eat, drink or smoke during handling.

Storage

- Store in a locked, well-ventilated, cool, dry area away from food, feed, seed and medicines.
- Do not subject to freezing or excessive heat.
- Store in original containers—do not store or use unlabeled pesticides.

Application

- Avoid drift—keep application within the intended treatment area.
- Treat from the shoreline outward to avoid trapping organisms in shallow water.
- In heavily infested, small bodies of water, treat only 1/3 to 1/2 of the area at a time—allowing 1 to 2 weeks between successive treatments.
- Keep application equipment functioning properly.
- Do not treat during adverse or changing weather conditions.
- Post signs or notify residents if the water is to be restricted for any of its uses (see chart, page 60).

Clean-up

- Clean and check application equipment.
- Flush out spray tanks, mixing barrels, etc.
- Wash up and change clothes.

Disposal

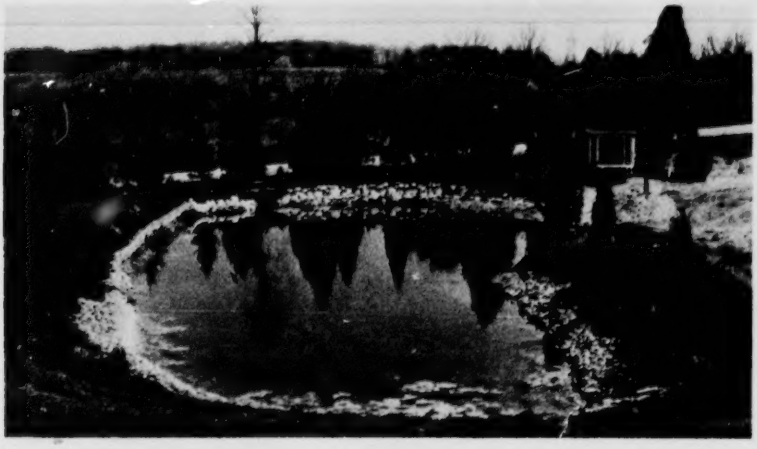
- Do not reuse empty pesticide containers.
- Empty containers should be triple-rinsed and disposed of in a sanitary landfill.
- Do not indiscriminantly dump unused material—dispose of in a safe place.

Spray Application - Photo courtesy of MARINE BIOCHEMISTS, INC.

If in doubt about using a pesticide, consult your, Soil Conservation Service, DNR, or County Agricultural Extension Agent.

LAKE AND POND MANAGEMENT

In addition to excessive weeds and algae, other problems can occur in lakes and ponds. Erosión, surface runoff, leakage, rough fish, burrowing animals, parasites, etc., can interfere with the appearance and use of a body of water. Individual pond owners can undertake some corrective control programs themselves. On a lake, however, the cooperation of all property owners is helpful in setting up maintenance programs.



Proper construction and shoreline management can prevent some of the common problems associated with water bodies. Suitable depths and steep slopes inhibit the growth of weeds. Establishment of suitable bank vegetation stabilizes shorelines, prevents erosion and adds natural beauty to the area. Rock-lined shores may be necessary in wave-washed areas to prevent erosion damage. Avoid dumping sand and other fill materials around the shore, as these substances will end up on the lake bottom.

Properly functioning waste disposal systems are of utmost importance around bodies of water. Septic Systems and drainage beds should be set far enough away from shorelines and drinking water supplies to prevent any possible contamination. Tests, using specific dyes, will determine if seepage is occurring. Garbage dumps and burning sites should be areas where ashes and runoff will not enter the water.

Land management techniques and water quality go hand in hand. Runoff from feedlots, agricultural fields and fertilized lawns and gardens should be prevented from entering lakes and ponds. Fencing of livestock, contour plowing and proper landscaping of water frontage can avoid some of these problems.

Fish management is an important consideration in many bodies of water. Raising fish and maintaining healthy populations requires time and effort. Decisions include selection of species, number of individuals, habitat manipulation and harvest methods. All fish require relatively high water quality, an available food source, suitable protective cover and proper spawning habitats to survive and maintain their populations. Problems often encountered include fish kills resulting from pollution or drastic fluctuations in water levels, temperatures and oxygen concentrations; stunting caused by excessive food competition or excessive weed cover; over-population of unwanted species due to accidental or mistaken introduction of these fish; and disease outbreaks caused by bacteria, fungi and parasites. Although this book will deal with some of these problems, consult your proper state agencies and resource material on this subject for a greater understanding.

Some of the more common pond or lake problems can often be corrected or minimized by relatively simple management techniques.

Low Oxygen Concentrations: In ponds and shallow lakes, dissolved oxygen concentrations sometimes fall below levels critical to support fish life. Aquatic plants and animals utilize oxygen in their metabolic and decay processes. Drastic oxygen depletion can occur under snow-covered ice or after extended periods of cloudy weather. A short-term emergency measure to reverse this condition is the application of 1 to 3 pounds of potassium permanganate ($KMnO_4$) per acre. In waters where oxygen depletion is a seasonal or recurring problem, installation of mechanical aerators is effective. They will not only mix air with the water, but prevent ice formation, thus allowing sunlight penetration, permitting plants to continue producing oxygen. However, reduction of weeds and algae from aeration is limited and should not be considered a control method.

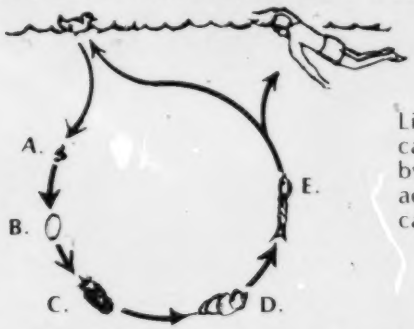
Aerator. Photo courtesy of Aqua-Aerobic Systems, Rockford, Il.

High Fertility: Besides limiting nutrient input by proper land management, an experimental technique can be used to inactivate existing nutrients chemically. Addition of aluminum sulfate or gypsum can reduce phosphate, a main contributor to plant growth.

Leakage: Seepage in ponds and lakes occurs when the basin soils are too porous to hold water. Sealing of the pond may be necessary. Consult your local soil conservation service agent to determine the best method for your particular situation. Techniques include using compaction, bentonite clay, chemical additives or waterproof linings.

Animal pests: Burrowing animals can damage shorelines and cause leaks in dams and spillways. Muskrats are often the main offenders. Lining banks with stone will discourage their burrowing. If the problem becomes severe, live traps placed in culverts are an effective and humane way of catching and transporting these animals to other areas. Wire netting can be placed across pipes to prevent nesting. Elimination of cattails, their favorite food, is also a deterrent.

Turtles, although not a severe problem, can become unwanted pests in swimming and fishing areas. They will rarely threaten fish populations, but may steal bait or eat fish off stringers. Floating live-box traps baited with fish, chicken entrails or liver work well. Snapping and soft shell turtle meat is a delicacy.



Life cycle of swimmers' itch cercariae: (A) blood fluke carried by water bird; (B) egg; (C) miracidia (D) snail host; (E) cercaria seeking host.

Swimmer's Itch: A nuisance parasite associated with snails sometimes causes problems in swimming areas. In one phase of its complex life cycle, it is an actively swimming organism called a **cercaria.** The cercariae can penetrate the outer layer of skin on bathers and cause red welts, itching and general discomfort. These symptoms show varying degrees of severity dependent upon sensitivity of the individual. Showering or thorough drying of the body after swimming can reduce the possibility of developing the irritation. Control of the organisms involves elimination of both the host snails and the free-swimming cercariae. Mobility of these organisms is limited; therefore, treatment areas can be confined to beaches and adjacent areas having high snail populations. A slurry of 80 pounds of copper sulfate mixed with 40 pounds of lime should be applied per acre. Bottom application of this material is safest and most effective. Do not treat more than 1/10 of water body at one time as this material can be toxic to fish. Allow 24 hours for chemical to settle out before entering the water. Treat when water and wind and current action is minimal. Re-infestations may occur due to strong onshore wind or currents which carry organisms in from untreated areas.

ALGAE

The algae are primitive plants closely related to the fungi. They exhibit no true leaves, stems or root systems and reproduce by means of spores, cell division or fragmentation. Some 17,400 species of algae have been identified and thousands more probably exist.

These organisms have adapted to many different habitats and exhibit a wide range of characteristics. They can be found in many places from hot springs to glaciers, fresh water to salt water and sandy beaches to rice paddies.

On the following pages, nuisance algal growths are classified into three general categories: planktonic, filamentous and attached-erect forms.

NOTE

Included with the illustrations on the following pages are our recommendations for aquatic weed or algae control. These recommendations are based upon many years of actual application experience by Dr. Domogalla and our own biologists.

In our recommendations, many factors have been considered: toxicity, ease of application, effectiveness and impact upon the environment. Based on specific use sites and conditions, alternative chemicals may be necessary. (See RESTRICTIONS on page 60.)

Only aquatic chemicals properly registered with the federal Environmental Protection Agency and/or a majority of state conservation commissions are recommended. Nevertheless, it is prudent to clear any pesticide with your proper State Agency before applying.

As of the printing of this book, the chemical "Silvex" has been banned in a number of States and is no longer being manufactured. References to this product as a Control Method does not intend endorsement of its use. Check its status in your State before purchasing or applying.

PLANKTONIC ALGAE - Common genera: Aphanizomenon, Anabaena, Microcystis, Chlorella and Scenedesmus

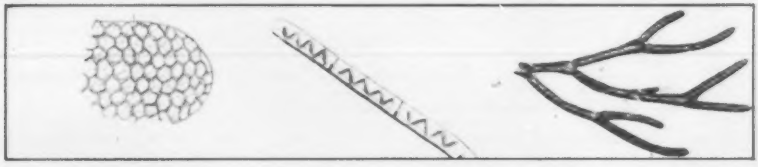
TIPS FROM THE EXPERTS
Usually, the entire body of water will require treatment for an effective job. Sometimes, however, planktonic algae, at the mercy of wave and current action, will accumulate along windward shores or in backwater areas thus reducing the size of the treatment area.

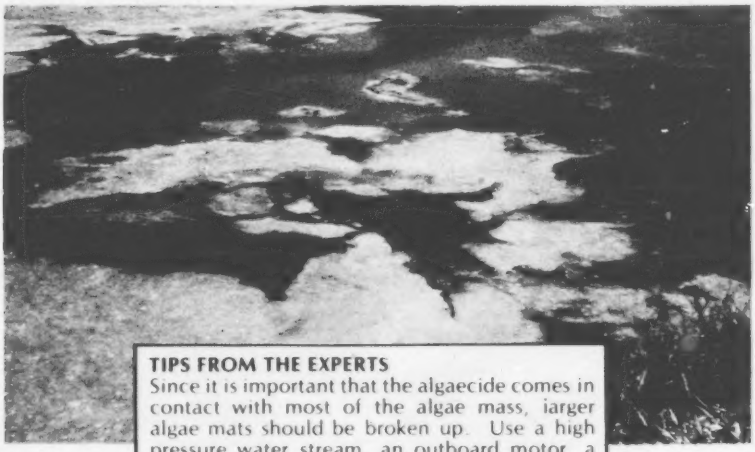
Description: Microscopic plants suspended in the upper few feet of water which, when overabundant, may cause what is commonly known as a planktonic bloom. The water may take on a pea soup green or brownish tinge. Natural die-offs of overabundant planktonic algae may cause summerkill of fish due to oxygen depletion. Some forms of planktonic algae release toxins in the water as they decompose which are a threat to livestock, wildlife and even man. Planktonic algae may impart tastes and odors to the water and make it undesirable for swimming and other recreational activities.

Distribution: Worldwide.

Recommended Control Method: Apply 0.6 gallons of CUTRINE-PLUS per acre-foot of water. Chemical should be diluted at least 9 to 1 to achieve uniform dispersion of algaecide in water. Treat two or three times a season when algae appears.

FILAMENTOUS ALGAE - Common genera: Spirogyra, Cladophora, Rhizoclonium, Mougeotia, Zygnema and Hydrodictyon





TIPS FROM THE EXPERTS
Since it is important that the algaecide comes in contact with most of the algae mass, larger algae mats should be broken up. Use a high pressure water stream, an outboard motor, a rake, or an oar.

Description: Also known as "pond scum" or "moss" because it forms greenish mats upon the water's surface. Filamentous algae usually begins its growth along the edges or bottom of the pond and "mushrooms" to the surface buoyed by the oxygen it has produced. Individual filaments are a series of cells joined end to end which give the thread-like appearance. They also form fur-like growths on bottom logs, rocks and even on the backs of turtles. The texture of these growths may be slimy, cottony or coarse. Common names such as frog spittle and water net have been given to a few common forms.

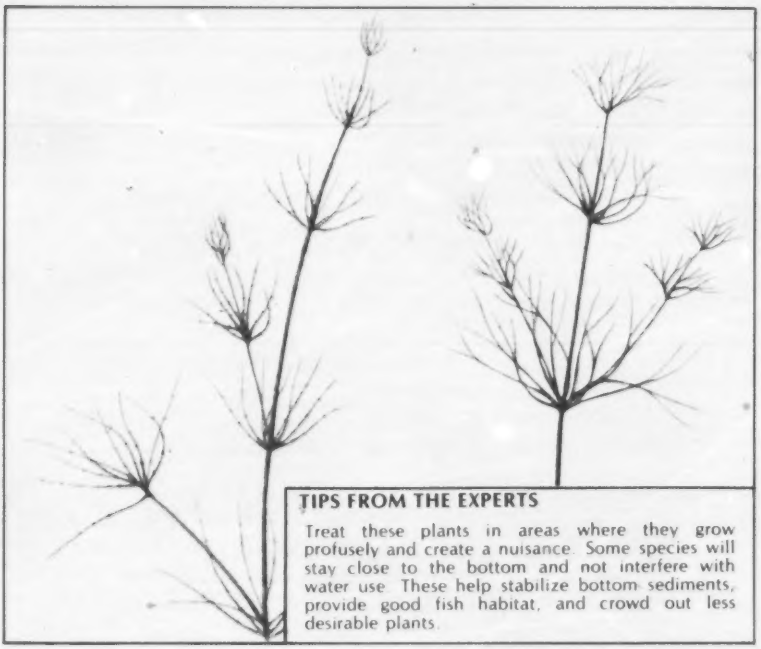
Distribution: Common in its many forms worldwide.

Recommended Control Method: Apply 0.6 gallons of CUTRINE-PLUS per acre-foot of water. Chemical should be diluted at least 9 to 1 to achieve uniform dispersion of algaecide in water. For treatment of bottom-growing algae, apply CUTRINE-PLUS GRANULAR at the rate of 60 pounds per acre. Granular can also be used to spot-treat localized bottom infestations.

Two or three total or spot treatments may be required to control regrowth during the season. Length of growing season, sunlight and temperature affect the rate of regrowth.

ATTACHED-ERECT ALGAE [Weed-like]

CHARA AND NITELLA - Common names: Muskgrass, Stonewort



TIPS FROM THE EXPERTS

Treat these plants in areas where they grow profusely and create a nuisance. Some species will stay close to the bottom and not interfere with water use. These help stabilize bottom sediments, provide good fish habitat, and crowd out less desirable plants.

Description: Advanced forms of algae, gray-green or yellow in appearance. They are often mistaken for higher vascular plants. Best way to identify it is by its musky odor and gritty, bristly feel due to calcium deposits on its surface. Leaf-like structures are whorled about the stem at fairly uniform intervals. Dense growths may cover entire bottom of pond or lake.

Distribution: Commonly found in hard water worldwide.

Recommended Control Method: Apply 60 pounds of CUTRINE-PLUS GRANULAR per acre of water. Best treatment results are achieved when plants are young and uncalcified.

OR

Where chara is in water less than 3 feet deep or where growth is near the surface, liquid CUTRINE-PLUS can be used. Apply 1.2 gallons of CUTRINE-PLUS per acre-foot of water. Dilute at least 9 to 1 with water to achieve uniform distribution of chemical.

In hard water, or those with thick infestations, two applications of chemical may be required for control of chara.

FLOATING WEEDS

Plants with leaves that float on the surface and are rooted on the bottom are included in this category. Free-floating surface plants which derive their nutrients directly from the water through the cell wall or by means of a well-developed root system are also in this group. Water is critical for support of plant or its leaves.

NOTE

In our recommendations, many factors have been considered: toxicity, ease of application, effectiveness and impact upon the environment. Based on specific use sites and conditions, alternative chemicals may be necessary. (See RESTRICTIONS on page 60.)

TIPS FROM THE EXPERTS
This family of plants is notorious for their rapid reproduction. Effective control is dependent upon chemical contact with as many of the plants as possible. This includes those washed up along shorelines or trapped in backwater areas. Several treatments may be necessary to achieve control.

DUCKWEED [Lemnaceae] family
Small, floating green plants which are often mistaken for algae. Reproduction is by means of fragmentation. Common in quiet water such as ponds or backwaters.

COMMON DUCKWEED [*Lemna minor*] - Figure A

Description: Plant oval, roots may or may not extend from bottom of plant.

STAR DUCKWEED [*Lemna trisulca*] - Figure B

Description: Plants long and narrow with stalked appendages and rootlets.

Distribution: Fairly common throughout the United States.

WATERMEAL [*Wolffia spp.*] - Figure C

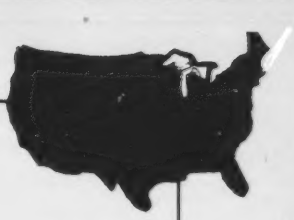
Description: Smallest of flowering plants, granular in size, usually abundant when present. No roots present. Plant often mistaken for seeds.

Distribution: Common in the eastern half of the United States.

Recommended Control Method: All members of the duckweed family can be controlled with the following combination: Tank-mix five gallons of WEEDTRINE-D and 1/2 gallon of CUTRINE-PLUS per surface acre. Dilute with sufficient water to enable even distribution as a fine surface spray. Plants reproduce by fragmentation and therefore repeated treatment may be necessary.

OR

For areas in excess of 1 acre, use 1 gallon of Diquat tank mixed with 1/2 gallon of CURTINE-PLUS per surface acre. Dilute with water and apply as above.



TIPS FROM THE EXPERTS
Some species will grow on the shoreline. These may also require treatment to prevent their breaking loose and re-establishing in new areas. Floating mats of these plants are also common

WATER PENNYWORT [*Hydrocotyle spp.*]

Description: Mature leaves round with broad lobes. Leaves about the size of a half dollar. Stalks extend from horizontal root buried in shallow water.

Distribution: Common throughout the United States but seldom reaching nuisance levels.

Recommended Control Method: For small areas apply 1/3 gallon of WEEDTRINE-D per 5,000 sq. ft. as a spray to saturate foliage.
OR
For areas in excess of 1 acre in size, use Diquat: 2 quarts liquid per surface acre.

TIPS FROM THE EXPERTS
The stems of chemically treated water lilies characteristically elongate and the leaves curl up after one or two weeks. Because of the tough nature of the leaf and petiole tissue, disappearance of the plant altogether may take some time.

WHITE WATER LILY [*Nymphaea spp.*] - **Common name:** Fragrant Water Lily.

Description: Large, round, cleft* leaf. Leaf veins radiate from point of attachment to petiole.* White flower with multiple rows of petals.

Distribution: Common in shallow water throughout the United States.

Recommended Control Methods: Apply 150-200 pounds of WEEDTRINE II GRANULAR per acre. Distribute chemical evenly to assure effective control.

Alternative Control Methods: Dichlobenil: 40-60 pounds of pellets per surface acre.

Granular Silvex and Endothall: 50-100 pounds per acre-foot of water.

Liquid Silvex and Endothall: 1 to 2 gallons per acre-foot.

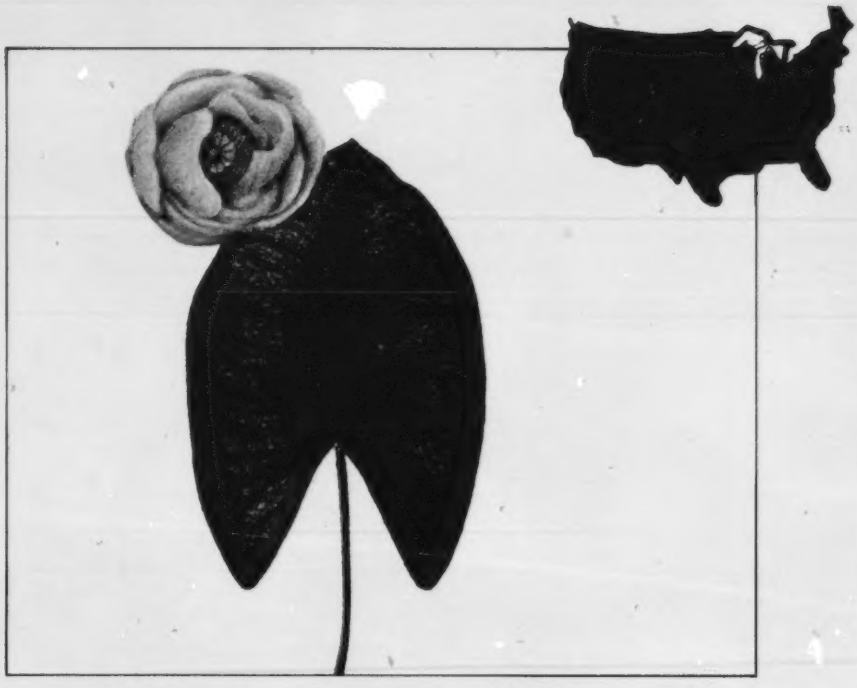
Granular Silvex: 20 to 40 pounds per acre.

Liquid Silvex: 8 ounces of liquid in 5 gallons of water with detergent to make water soapy; spray on foliage.

Liquid 2, 4-D ester: 8 ounces of liquid in 5 gallons of water with a detergent to make water soapy; spray on foliage.

Granular 2, 4-D: 150-200 pounds of granular per surface acre.

* cleft: cut about half way to the mid vein.
* petiole: the stalk of a leaf blade.



YELLOW WATER LILY [*Nuphar spp.*] - **Common names:** Spatterdock, Yellow Cow Lily.

Description: Leaves large, heart-shaped. Leaf veins extending laterally from midrib. Flower is bright yellow, with a single row of petals.

Distribution: Common in shallow water throughout the United States. Prefer muck or silt bottom.

Recommended Control Methods: Apply 150-200 pounds of WEEDTRINE II GRANULAR per acre. Distribute evenly to assure effective control.

Alternative Control Methods: Dichlobenil: 40-60 pounds of pellets per surface acre.

Granular Silvex and Endothall: 50-100 pounds per acre-foot of water.

Liquid Silvex and Endothall: 1 to 2 gallons per acre-foot

Granular Silvex: 20 to 40 pounds per acre.

Liquid Silvex: 8 ounces of liquid in 5 gall[illegible] of water with detergent to make water soapy; spray on foli[illegible]

Liquid 2, 4-D ester: 8 ounces of liquid in [illegible]allons of water with a detergent to make water soapy; spray or[illegible]li[illegible]ge.

Granular 2, 4-D: 150-200 pounds of gran[illegible] per surface acre.

TIPS FROM THE EXPERTS
Both cold weather and certain insects are prime enemies of this plant. Chemical methods are best used in areas where year-round control is desired.

WATER LETTUCE [*Pistia stratioties*]

Description: Plants consist of distinct rosette* of light yellow-green leaves. Tuft of long unbranched, fibrous roots extending into water from fleshy rhizome. Leaves have definite veins radiating from leaf base toward leaf margin.

Distribution: Commonly found in quiet water areas in Florida as well as isolated areas in other gulf coast states.

Recommended Control Method: Apply WEEDTRINE-D as a surface spray on foliage at the rate of 1.25 to 1.6 gallons per surface acre.

OR

For areas in excess of 1 acre in size; use Diquat: apply 1 to 1-1/2 quarts of liquid per surface acre.

* rosette: a dense basal cluster of leaves arranged in circular fashion like the leaves of the common dandelion.

TIPS FROM THE EXPERTS
Dense growths of these plants may be beneficial in deeper canals. They help shade out underlying submerged weeds which often interfere with navigation and impede water flow. Chemical should be sprayed directly onto foliage.

SALVINIA [*Salvinia rotundifolia*]

Description: Leaves small and bright green and arranged along a common stem. The leaf has a distinct midrib and often appears folded along its axis.*

Distribution: Introduced from Mexico or South America. The plant is commonly found in Florida in association with alligator weed and water hyacinth.

Recommended Control Method: For small areas apply 1/3 to 1/2 gallons of WEEDTRINE-D per 5,000 sq. ft. of water. (Use higher rate for dense growth.)

OR

For areas in excess of 1 acre in size, use Diquat: 2 to 4 quarts of liquid per surface acre.

*axis: the stem; the longitudinal support on which organs are arranged.

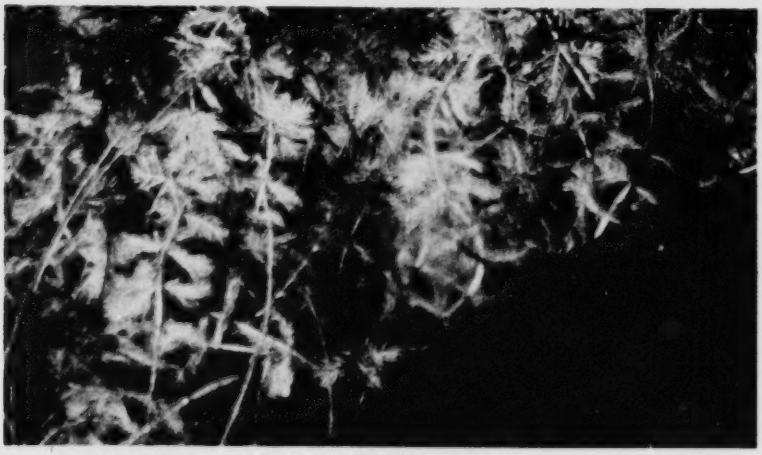
SUBMERGED WEEDS

Plants which are generally rooted at the bottom and are completely submerged are in this category. Submerged weeds are usually flaccid and lack rigid cellular tissue. Flowers, if present, may extend above the water surface.

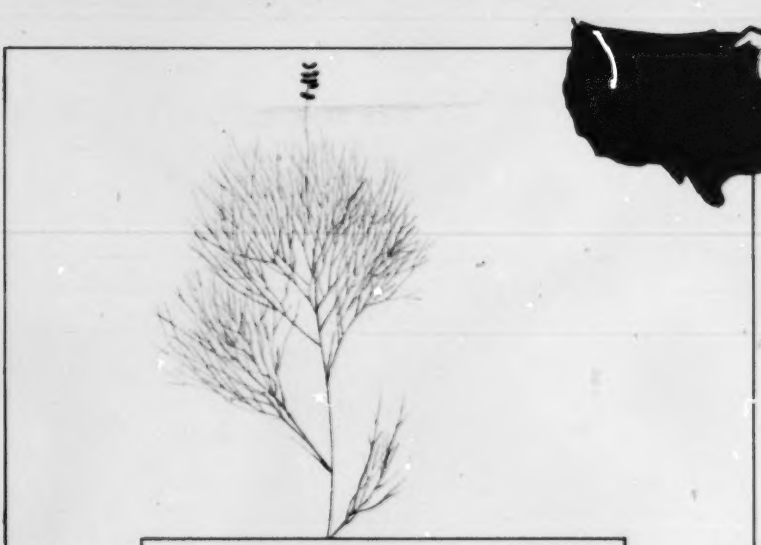
flaccid: lax and weak; without rigidity.

NOTE

In our recommendations, many factors have been considered: toxicity, ease of application, effectiveness and impact upon the environment. Based on specific use sites and conditions, alternative chemicals may be necessary. (See RESTRICTIONS on page 60.)



Milfoil. [Myriophyllium spp.]



TIPS FROM THE EXPERTS
Treat these plants before seeds appear. This may not only prevent a regrowth later in the season, but may reduce this weed's population in subsequent years. In waterfowl areas, plant is a valuable food source.

SAGO PONDWEED [*Potamogeton pectinatus*]

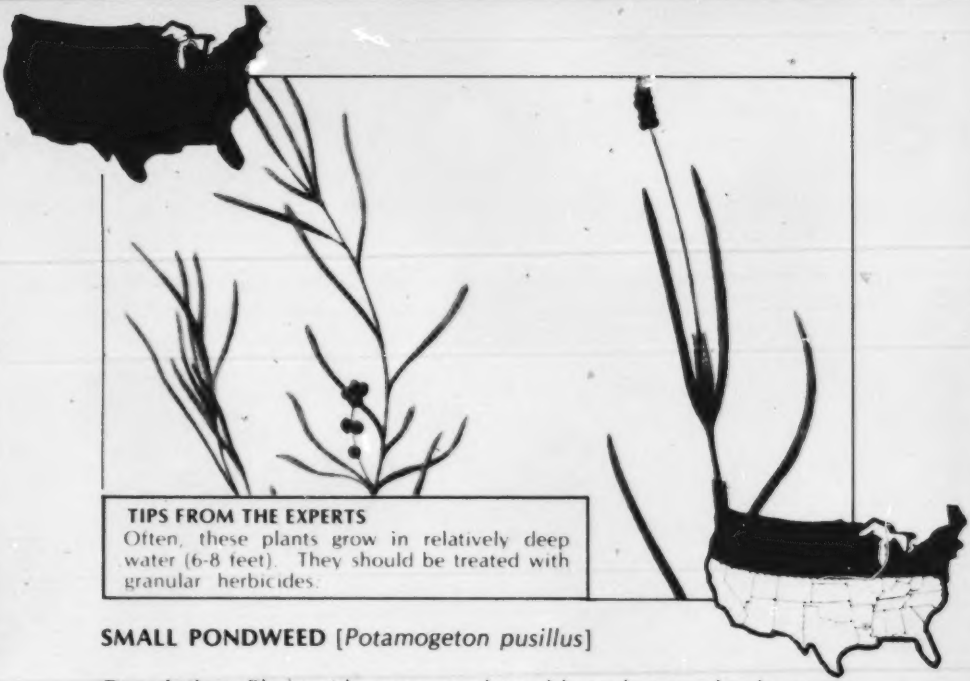
Description: Plants bushy in appearance with narrow thread-like leaves alternately arranged on stem. Nutlets* arranged like beads spaced on a string and emerging from the water. Leaves alternately arranged on stem.

Distribution: Occurs throughout the U.S. in highly variable forms based on local conditions.

Recommended Control Method: Mix CUTRINE-PLUS and potassium endothall as a tank-mix at the rate of 1 CUTRINE-PLUS to 2 endothall and apply at the rate of 1.0 gallons per acre-foot of water.

Alternative Control Methods: Granular endothall: 27-54 pounds per acre-foot.
Liquid potassium endothall: 0.6 gallons per acre-foot.
Diquat: 0.5 gallons per acre-foot.
Dichlobenil: 100 to 150 pounds per surface acre.
Liquid Silvex and endothall: 0.5 gallons per acre-foot.
Granular Silvex and endothall: 26 pounds per acre-foot.

* nutlets: a small nut or nut-like fruit.



TIPS FROM THE EXPERTS
Often, these plants grow in relatively deep water (6-8 feet). They should be treated with granular herbicides.

SMALL PONDWEED [*Potamogeton pusillus*]

Description: Plant with numerous lateral branches on slender stem. Narrow ribbon-like leaves alternately arranged on branches. Leaves tapered to point of attachment on stem. Nutlets arranged on spike in loose pattern.

Distribution: Found throughout the U.S. A common nuisance species in ponds, lakes and irrigation ditches.

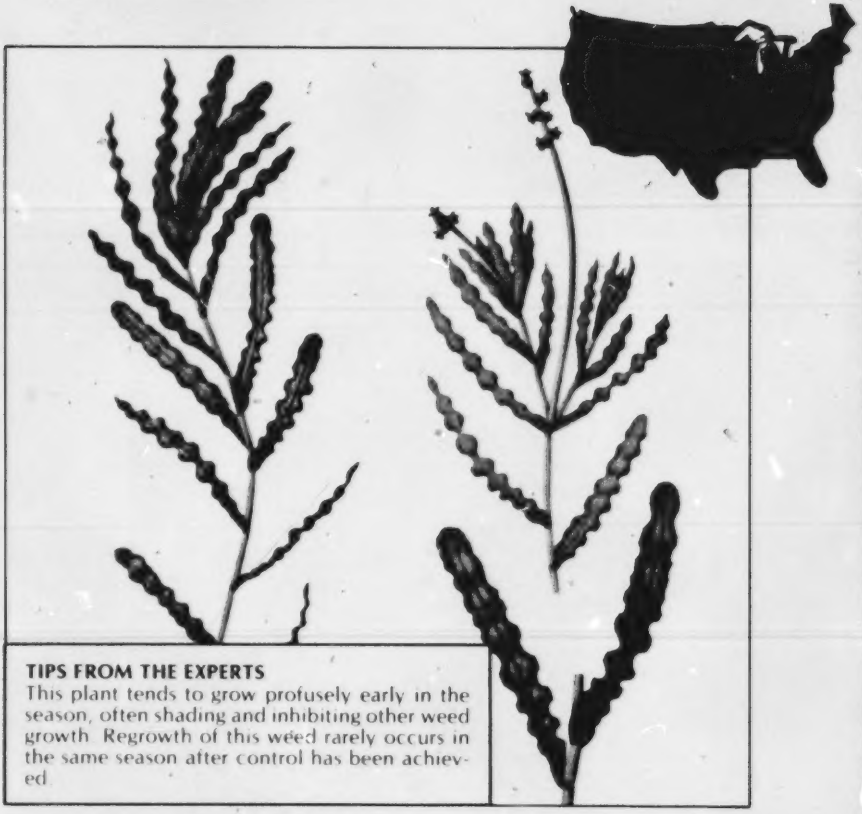
Similar Species: FLATSTEM PONDWEED [*Potamogeton zosteriformis*]

Description: Stem large and conspicuously flattened. Leaves ribbon-like and extended upwards from flattened surface of stem.

Distribution: Common throughout northern one-half of U.S. Plants seldom reach nuisance levels.

Recommended Control Method: Tank mix 1 gallon of CUTRINE-PLUS and 2 gallons of potassium endothall and apply at the rate of 1.0 gallons of the mix per acre-foot of water.

Alternative Control Methods: Granular endothall: 27-54 pounds per acre-foot.
Liquid potassium endothall: 0.6 gallons per acre-foot.
Diquat: 0.5 gallons per acre-foot.
Dichlobenil: 100 to 150 pounds per surface acre.
Liquid Silvex and endothall: 0.5 gallons per acre-foot.
Granular Silvex and endothall: 26 pounds per acre-foot.



TIPS FROM THE EXPERTS
This plant tends to grow profusely early in the season, often shading and inhibiting other weed growth. Regrowth of this weed rarely occurs in the same season after control has been achieved.

CURLYLEAF PONDWEED [*Potamogeton crispus*]

Description: Leaves thin and membranous with veins plainly visible. Minute teeth visible along entire margin of leaf. Commonly grows early in the spring and dies back during mid-summer. Fruits borne in spike above water surface. Leaves alternately arranged on stem.

Distribution: Common throughout the U.S. in fresh and brackish water.

Recommended Control Method: Mix CUTRINE-PLUS and potassium endothall as a tank-mix at the rate of 1 CUTRINE-PLUS to 2 endothall and apply at the rate of 1.0 gallons per acre-foot of water.

Alternative Control Methods: Granular endothall: 13-40 pounds per acre foot.
Liquid potassium endothall: 0.3 to 1.0 gallons per acre-foot.
Diquat: 0.7 gallons per acre-foot.
Liquid Silvex and endothall: 0.25 to 0.75 gallons per acre-foot.
Granular Silvex and endothall: 13-39 pounds per acre-foot.

TIPS FROM THE EXPERTS
These two species are notorious for their resistance to chemical control. Often growing in patches or beds, the tough stems and leaves remain standing and intact even after death of the plant, especially in hard waters.

LARGE-LEAF PONDWEED [*Potamogeton amplifolius*]

Description: Large, thick stem with wavy, recurved, oblong, submersed leaves which taper to stem. Floating leaves are ovate* Solid, tightly-packed spike of nutlets at tip of plant. Plant seldom branched.

Distribution: Common in hard water throughout the northern one-half of U.S. Plants often appear brown due to mineral deposits on leaves.

Similar Species: CLASPING LEAF PONDWEED [*Potamogeton richardsonii*]

Description: Leaves wide and wavy with a broad base which appears to extend three-quarters of the way around the stem. Upper stem commonly branched and leafy. Leaves alternately arranged on stem.

Distribution: Common in hard water throughout the northern one-half of U.S. Plants often appear brown due to mineral deposits on leaves.

Recommended Control Method: Mix CUTRINE-PLUS with potassium endothall in the ratio of 1:2 and apply at the rate of 2 gallons of the mix per acre-foot.

Alternative Control Methods: Granular endothall: 27 to 54 pounds per acre-foot of water.

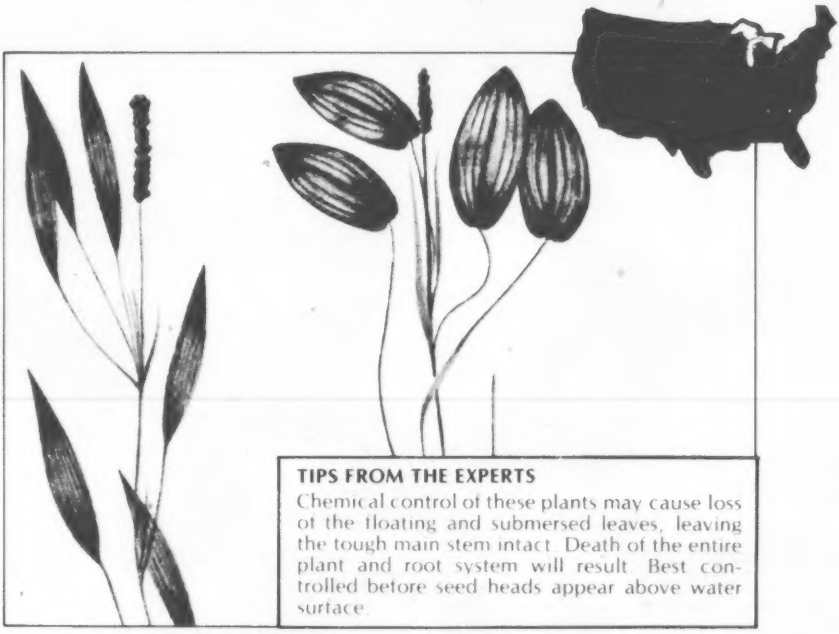
Liquid potassium endothall: 0.6 to 1.3 gallons per acre-foot of water.

Dichlobenil: 100 to 150 pounds per surface acre.

Liquid Silvex and endothall: 0.5 to 1.0 gallons per acre-foot.

Granular Silvex and endothall: 26 to 51 pounds per acre-foot.

* ovate: egg-shaped in outline, attached at the wide end.



TIPS FROM THE EXPERTS

Chemical control of these plants may cause loss of the floating and submersed leaves, leaving the tough main stem intact. Death of the entire plant and root system will result. Best controlled before seed heads appear above water surface.

AMERICAN PONDWEED [*Potamogeton nodosus*]

Description: Floating leaves oval with base tapered to distinct petiole. Submersed leaves oval to lance-like, tapered to long petiole. Generally plant has sparse leafing. Leaves alternately arranged on stem.

Distribution: Widespread and common throughout U.S.

Similar Species: ILLINOIS PONDWEED [*Potamogeton illinoensis*]

Description: Similar to above species. Submersed leaves differ from above in that petiole is extremely short.

Floating-Leaf Pondweed [*Potamogeton natans*]

Description: Floating leaves slightly heart-shaped at base. Submersed leaves long and narrow or absent.

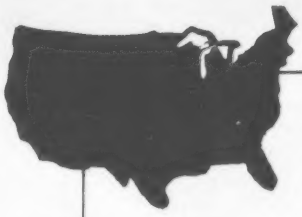
Recommended Control Method: Tank-mix CUTRINE-PLUS and potassium endothall at the ratio of 1 to 2 gallons and apply at the rate of 1.5 gallons per acre-foot of water.

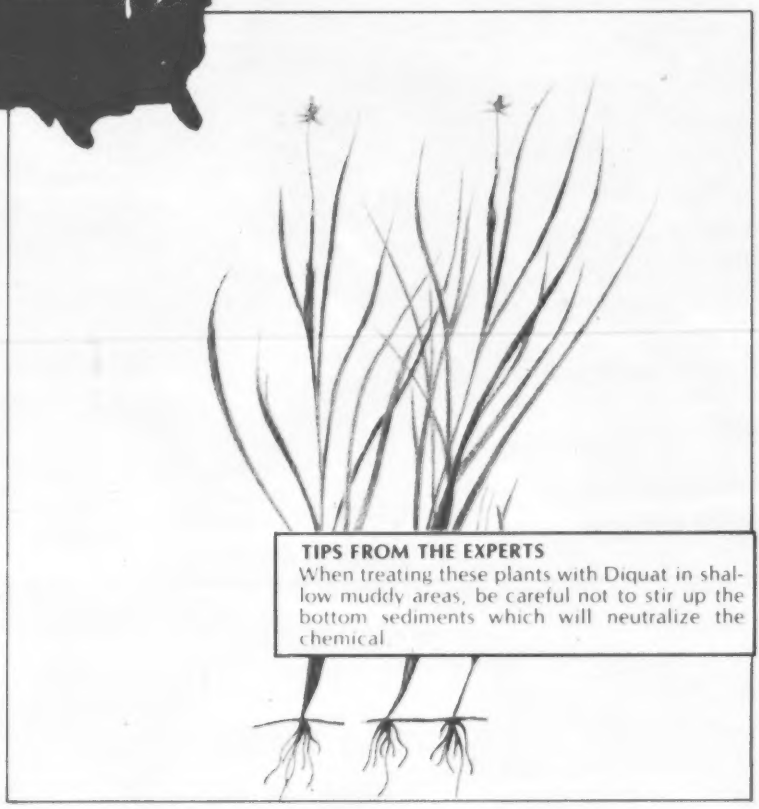
Alternative Control Methods: Granular endothall: 27 to 54 pounds acre-foot of water.

Liquid potassium endothall: 0.6 to 1.3 gallons per acre-foot of water.

Dichlobenil: 100 to 150 pounds per surface acre.

Liquid Silvex and endothall: 0.5 to 1.0 gallons per acre-foot.





TIPS FROM THE EXPERTS
When treating these plants with Diquat in shallow muddy areas, be careful not to stir up the bottom sediments which will neutralize the chemical.

WATERSTARGRASS [*Heteranthera dubia*]

Description: Stems and leaves long, flexible, grass-like. Found submersed in shallow water. Leaves flaccid with visible midrib. Flower small, yellow and star-shaped.

Distribution: Found throughout the U.S., generally in still water.

Recommended Control Method: For areas less than one acre, apply 2 gallons of WEEDTRINE-D per acre-foot of water.

Alternative Control Methods: Granular endothall: 54 to 81 pounds per acre-foot.
Diquat: 0.35 gallons per acre-foot.
Liquid potassium endothall: 1.3 to 1.0 gallons per acre-foot.
Granular endothall and Silvex: 51 to 77 pounds per acre-foot.
Liquid endothall and Silvex: 1.0 to 1.6 gallons per acre-foot.

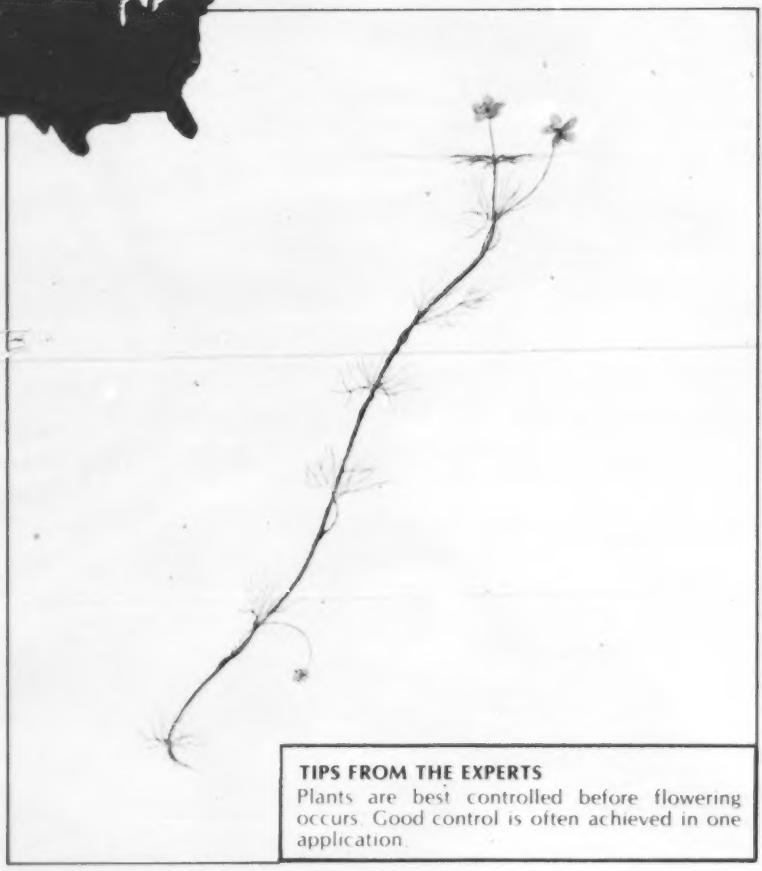
TIPS FROM THE EXPERTS
Very difficult to control. Floating, uprooted plants often re-establish themselves in shallow waters. Take note of "Fish Caution" on label.

WILD CELERY, TAPEGRASS, EELGRASS [*Vallisneria americana*]

Description: Roots buried in mud with tufts of ribbon-like, flaccid leaves. Horizontal stem system connecting tufts of leaves. Flower visible late in summer supported by coiled stalk.

Distribution: Commonly found in fresh water from the Great Plains east to the coast.

Recommended Control Method: Apply granular Hydrothol 47 over water surface at the rate of 0.5 to 3.5 ppmw active ingredient. This equals 27 lbs. to 170 lbs. per acre-foot.



TIPS FROM THE EXPERTS
Plants are best controlled before flowering occurs. Good control is often achieved in one application.

WATER BUTTERCUP [*Ranunculus spp.*]

Description: Submersed stem erect in water. Tufts of thread-like leaves alternating along stem. Conspicuous yellow or white flower emerging from water in June through September. Do not confuse with Chara. See page 26.

Distribution: Various species common throughout United States.

Recommended Control Method: For small areas apply 1 gallon of WEEDTRINE-D per 5,000 sq. ft. of water. Inject into water or spray over surface to obtain uniform distribution.

OR

For areas in excess of 1 acre in size, use Diquat at the rate of 0.7 gallon per acre-foot.

Alternative Control Method: Liquid endothall and Silvex: 1.0 gallons per acre-foot.

Granular endothall and Silvex: 51 pounds per acre-foot.

TIPS FROM THE EXPERTS
Plants often grow in thick clumps or beds. Good coverage and dispersion of chemical is required to achieve control.

SOUTHERN NAIAD [*Najas guadalupensis*]

Description: Plant very leafy. Leaves wider at base and arranged oppositely on plant stem. Tiny seed concealed at axis of leaf. Leaf margin with visible spines.

Similar Species - COMMON NAIAD [*Najas flexilis*]

Description: Leaves tapered to fine point with minute spines on margin.

Distribution: Both species are common and widespread with considerable overlap in range.

Recommended Control Method: For small areas apply 2 gallons of WEEDTRINE-D per 5,000 sq. ft. of water as a surface spray.

OR

For areas in excess of 1 acre in size, use Diquat at the rate of 1.4 gallons per acre-foot.

Alternative Control Methods: Dichlobenil: 100 to 150 pounds per surface acre applied as pre-emergent.
Potassium endothall: 0.3 to 1.0 gallons per acre-foot.
Granular potassium endothall: 13 to 40 pounds per acre-foot.
Liquid endothall and Silvex: 1 to 1.5 gallons per acre-foot.
Granular endothall and Silvex: 51 to 77 pounds per acre-foot.

TIPS FROM THE EXPERTS
Plants disintegrate readily after they die. Use Diquat in shallow areas, Weedtrine K Granular in deeper waters (4 feet or greater).

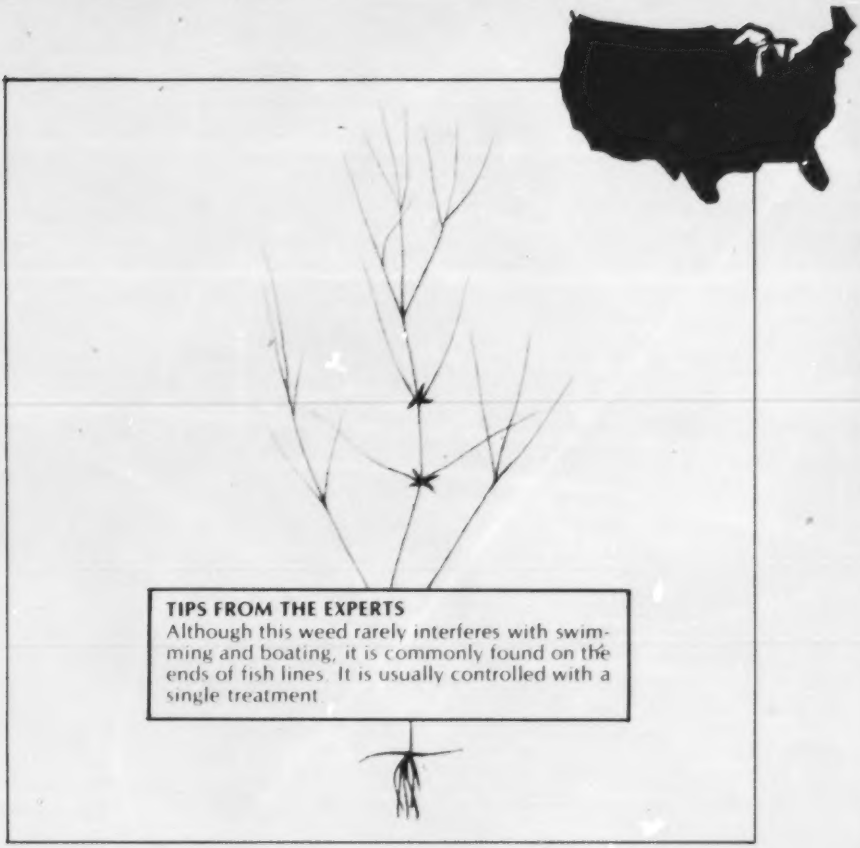
BRITTLE NAIAD [*Najas minor*]

Description: Long, pointed leaves with distinct spines. Leaves oppositely arranged on stem. Entire plant brittle and breaks easily.

Distribution: Found throughout the U.S. but seldom reaching nuisance concentration.

Recommended Control Method: For small areas apply 1 gallon WEEDTRINE-D per 5,000 sq. ft. of water as a surface spray. One acre or more, use diquat: 1.4 gallons per acre-foot.

Alternative Control Methods:
Granular endothall: 13 to 40 pounds per acre-foot.
Liquid Potassium endothall: 0.3 to 1.0 gallons per acre-foot.
Liquid endothall and Silvex: 0.25 to 0.75 gallons per acre-foot.
Granular endothall and Silvex: 13 to 39 pounds per acre-foot.



TIPS FROM THE EXPERTS
Although this weed rarely interferes with swimming and boating, it is commonly found on the ends of fish lines. It is usually controlled with a single treatment.

HORNED PONDWEED [*Zannechellia palustris*]

Description: Unlike the pondweeds, this species has all leaves oppositely arranged on the stem. Fragile stem rises from horizontal root. Leaves are long and narrow with flattish seeds attached to the stem at the base of the leaves.

Distribution: Species and its varieties found throughout the U.S. in fresh or brackish water. Not a common nuisance species.

Recommended Control Method: Tank-mix CUTRINE-PLUS and potassium endothall at the ratio of 1 to 2 gallons and apply at the rate of 1.0 gallon per acre-foot of water.

Alternative Control Methods: Granular endothall: 27 to 54 pounds per acre-foot.
Liquid potassium endothall: 0.6 to 1.3 gallons per acre-foot.
Liquid endothall and Silvex: 0.5 to 1.0 gallons per acre-foot.
Granular endothall and Silvex: 26 to 51 pounds per acre-foot.

TIPS FROM THE EXPERTS
Because it can grow in cold waters, Widgeon Grass often has a competitive advantage over other aquatics. Treatments should be made as early in the season as possible. Important waterfowl food.

WIDGEON GRASS [*Ruppia maritima*]

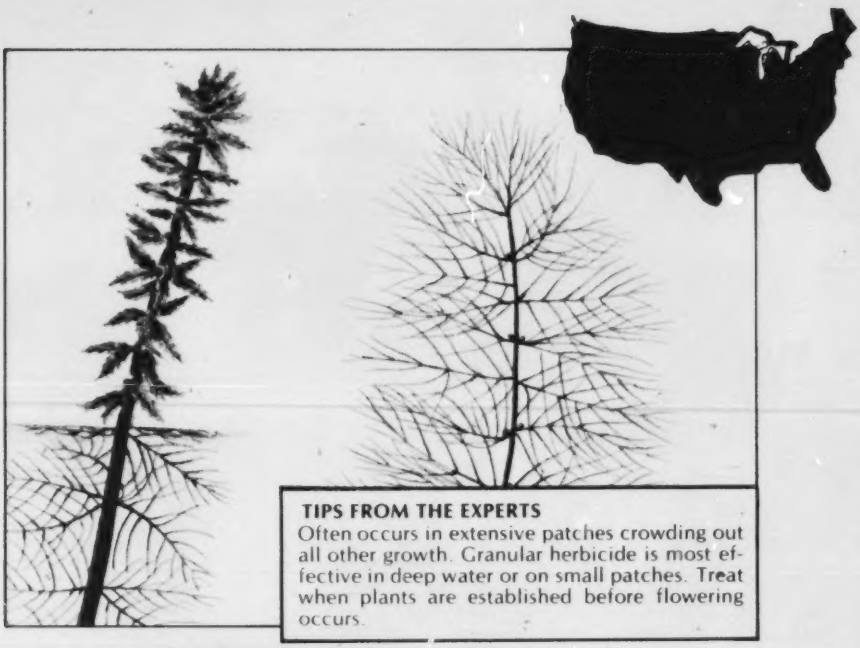
Description: Leaves thread-like, narrow, extending from extensive buried root sytem. Four to six fruits borne in clusters on short stalks at the top of the plants.

Distribution: Commonly found in salt water along the entire coast of the U.S. Very rarely found inland. Plant is a prime waterfowl food and desirable in some locations.

Recommended Control Method: For small areas apply 1 gallon of WEEDTRINE-D per 5,000 sq. ft. of water as a surface spray.

OR

For areas in excess of 1 acre in size, use Diquat at the rate of 0.7 gallons per acre-foot.



TIPS FROM THE EXPERTS
Often occurs in extensive patches crowding out all other growth. Granular herbicide is most effective in deep water or on small patches. Treat when plants are established before flowering occurs.

MILFOIL [*Myriophyllum spp.*]

Description: Stem hollow with whorled leaves at intervals along entire length of plant. Leaves finely dissected to midrib and featherlike in appearance. Plant submerged except for a stalk of tiny flowers which may extend above water surface. Do not confuse with Chara. See page 26.

PARROT FEATHER [*Myriophyllum brasiliense*]

Description: An escaped South American species; has stem and featherlike leaves extending above water surface. Do not confuse with Chara. See page 26.

Distribution: Numerous species of milfoil are common throughout the U.S. with **EURASIAN MILFOIL** [*Myriophyllum spicatum*] the most common nuisance speci.

Recommended Control Method: Apply WEEDTRINE II GRANULAR at the rate of 100 pounds per acre.

OR

Liquid 2, 4-D at the rate of 1.4 gallons per acre-foot.

Alternative Control Methods: Liquid Silvex: 1.4 gallons per acre-foot.
Granular endothall: 81 pounds per acre-foot.
Granular 2, 4-D: 27 pounds per acre-foot.
Diquat: 0.7 gallons per acre-foot.
Liquid potassium endothall: 1.3 to 1.9 gallons per acre-foot.
Dichlobenil: 100 to 150 pounds per surface acre.
Liquid endothall and Silvex: 1 to 1.6 gallons per acre-foot.
Granular endothall and Silvex: 51 to 77 pounds per acre-foot.

TIPS FROM THE EXPERTS
Treat when plants have accumulated in shallow waters. Floating plants buoyed up by algae growth should be treated with liquid spray.

COONTAIL [*Ceratophyllum demersum*]

Description: Plants submersed without roots. Leaves dark green in color and arranged in whorls on the stem. Coontail can be distinguished from milfoil by the forking of the leaves rather than the featherlike divisions. Spacing between leaf whorls is highly variable. Consequently, plants may be bushy or extremely long and sparse.

Distribution: Found throughout the U.S., usually in hard water.

Recommended Control Method: Apply WEEDTRINE II GRANULAR at the rate of 100 pounds per acre. OR
Liquid 2,4-D at the rate of 1.4 gallons per acre-foot.

Liquid endothall and Silvex: 0.5 to 1.0 gallons per acre-foot.
Granular endothall and Silvex: 26 to 51 pounds per acre-foot.
Granular 2, 4-D ester: 27 pounds per acre-foot.
Liquid Silvex: 1.4 gallons per acre foot.
Diquat: 1.4 gallons per acre-foot.
Liquid potassium endothall: 1.3 gallons per acre-foot.
Granular endothall: 54 to 81 pounds per acre-foot.
Dichlobenil: 100 to 150 pounds per surface acre.

TIPS FROM THE EXPERTS
Best treated when plants are matured. Fragmented portions can develop into new plants so good chemical coverage is necessary.

AMERICAN ELODEA [*Elodea canadensis*]

Description: Submersed weed with broad oval leaves usually four in number, arranged in whorls around stem. Whorls compact near growth tip and gradually increasing the spacing further down the stem.

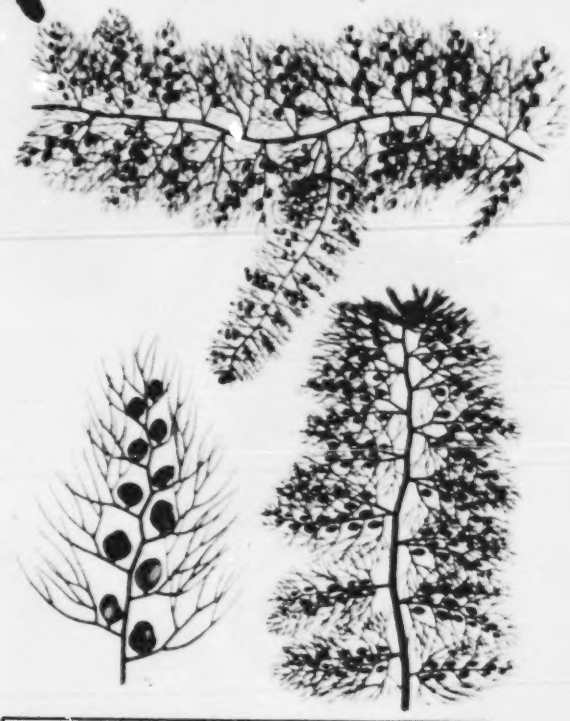
Distribution: Usually found in hard water. Common in the Northern and North Central states south to Kentucky and Virginia.

Recommended Control Method: Tank-mix 5 parts WEEDTRINE-D and1 part CUTRINE-PLUS and apply at the rate of 6 gallons per acre-foot.

OR

For areas larger than one acre use CUTRINE-PLUS and Diquat in a ratio of 1:1 and apply at the rate of 2 gallons per acre-foot.

Alternative Control Methods: Diquat: 1.4 gallons per acre-foot.
Dichlobenil: 100 to 150 pounds per surface acre.
Liquid endothall and Silvex: 1 to 1.6 gallons per acre-foot.
Granular endothall and Silvex: 51 to 77 pounds per acre-foot.



TIPS FROM THE EXPERTS
This plant is not rooted and floating plants may reinfest treated areas.

BLADDERWORT [*Utricularia spp.*]

Description: Plants are free-floating and without visible roots. Finely divided leaves scattered along stem with numerous small bladder-like structures on leaves. These bladders act as traps to capture small aquatic invertebrates.

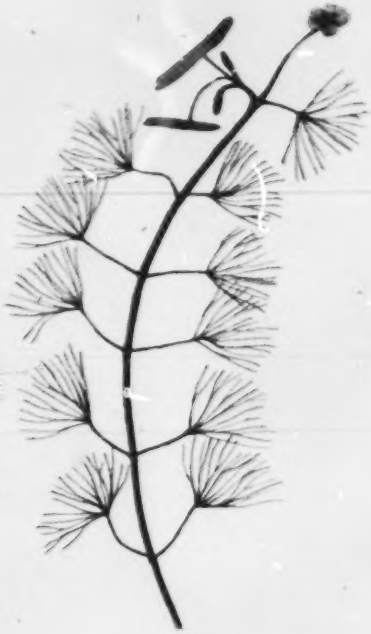
Distribution: Genus common throughout the United States in its various forms.

Recommended Control Method: For small areas apply 1 gallon of WEEDTRINE-D per 5,000 sq. ft. of water.

OR

For areas in excess of one acre in size use Diquat: 1 to 2 gallons per surface acre.

Alternative Control Methods: Liquid Silvex: 0.7 gallons per acre-foot.



TIPS FROM THE EXPERTS
Since it is often found growing in deeper waters, note water depth to determine proper application rates.

CABOMBA [*Cabomba caroliniana*] - **Common name:** Fanwort

Description: Submersed leaves oppositely arranged on stem. Leaves fanshaped and dissected into many narrow segments. Undissected floating leaves may also be present. Emergent white to light yellow flower. Do not confuse with Chara. See page 26.

Distribution: Southeastern quarter of U.S., north to central Illinois.

Recommended Control Method: For small areas use 2 gallons of WEEDTRINE-D per 5,000 sq. ft. of water.
OR
For areas in excess of 1 acre use Diquat: 1.4 to 2.8 gallons per acre-foot.

TIPS FROM THE EXPERTS
Care should be taken to remove weed fragments from equipment, boats, and trailers since infestation of new areas can occur by human transportation.

HYDRILLA [*Hydrilla verticillata*] - **Common name:** Florida Elodea

Description: Stem long and branched with oppositely arranged leaves at the bottom and whorls of three leaves on upper portions of the plant. Leaf oval-shaped with margins toothed. Plant fragments are capable of reproduction.

Distribution: Gulf States

Similar Species: BRAZILIAN ELODEA [*Egeria densa*]

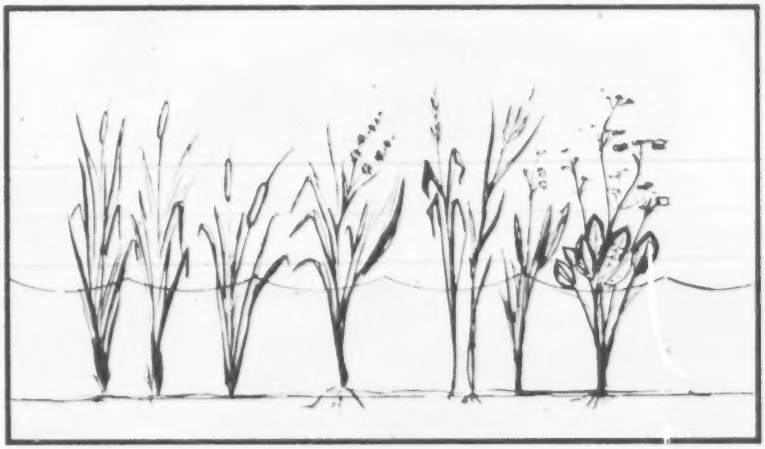
Description: Plants very similar to Hydrilla but leaves are not toothed. A visible inspection and handling of the leaves will quickly distinguish it from Hydrilla. Both species are controlled with similar treatment.

Distribution: Gulf States

Recommended Control Method: Tank-mix 3-1/3 gallons of CUTRINE-PLUS with 2 gallons of Diquat and inject below the surface. For soft water, reduce CUTRINE-PLUS to 2 gallons. Above recommendations will treat one acre.

EMERGENT WEEDS

Plants which grow above the water in shallow areas of ponds, lakes, irrigation ditches and rivers are emergent. These plants are generally rigid and are not dependent on water for support. Many are not truly aquatic but can survive in saturated soils or submerged for a considerable period in water.



NOTE

In our recommendations, many factors have been considered: toxicity, ease of application, effectiveness and impact upon the environment. Based on specific use sites and conditions, alternative chemicals may be necessary. (See RESTRICTIONS on page 60.)

TIPS FROM THE EXPERTS
To assure good control, spray chemical until it runs off plant.

CATTAIL [*Typha spp.*]

Description: Long, slender, grass-like stalks up to 10 feet in height. Inhabits wet lowlands and water to 4 feet deep.

Distribution: Common throughout the United States.

Recommended Control Method: Five ounces of WEEDTRINE-D per 3 gallons of water and one ounce of wetting agent (detergent) sprayed on foliage. Plants should be sprayed before seed head is formed to prevent re-seeding.

Alternative Control Methods: Four ounces of 2, 4-D in one gallon of kerosene sprayed on foliage.

Dalapon: 4 ounces of powder in one gallon of water sprayed on plants to thoroughly we' foliage.

Diquat: 1 ounce per 3 gallons of water and wetting agent (detergent) sprayed on plants.

Approximately 200 gallons of the above solutions will be needed to treat one acre.

TIPS FROM THE EXPERTS
Both plants can live on mud flats and moist soils so care should be taken to treat these areas

SMARTWEED, KNOTWEED [*Polygonum spp.*]

Description: Erect rooted herbaceous plant with alternate, oblong leaves. Stem is distinctly jointed. Small, tightly clustered flowers, generally pink or rose-colored. Plant may be emergent in shallow water or completely submersed with only flowers visible above surface.

Distribution: Numerous species found throughout the United States.

CREEPING WATER PRIMROSE [*Jussiaea repens*]

Description: Plant generally found in shallow water growing horizontally near the surface. Bright yellow flower distinguishes it from Smartweed.

Recommended Control Method: Both plants can be controlled in a similar manner. Apply 2, 4-D at the rate of 4 ounces per gallon of water and spray on foliage.

Alternative Control Methods: Liquid Silvex: 2 ounces per gallon of water sprayed on plants.

Granular 2, 4-D ester: 100 pounds per acre.

Diquat: 1 ounce per gallon of water sprayed on plants.

TIPS FROM THE EXPERTS
Tough stems may persist after death of plant. These may require mechanical removal.

WATERWILLOW [*Dianthera americana*]

Description: Emergent. Leaves opposite and lanceolate* without a petiole. Perennial plant with purplish flower extending from base of leaf. Stem thick and spongy.

Distribution: Eastern U.S., common in shallow water.

Recommended Control Method: Mix 2 ounces of 2, 4-D in a gallon of water and spray on foliage.

Alternative Control Methods: Granular 2, 4-D: 20 pounds per acre.
Liquid Silvex: 2 ounces in one gallon of water sprayed on plants.

* lanceolate: lance-shaped, several times longer than wide, broadest toward the base and tapering to the apex.

TIPS FROM THE EXPERTS
Selective insect control methods may provide long range solution to alligator weed infestation.

ALLIGATOR WEED [*Alternanthera philoxeroides*]

Description: Alligator Weed grows as a mat of interwoven plants. Leaves glossy, ovate with distinct midrib. Arrangement of leaves opposite on hollow stem. Flower white.

Distribution: Coastal states from Virginia to Texas in shallow water. Free-floating mats are also common and hinder navigation.

Recommended Control Method: Apply 2 gallons of Silvex (4 lbs. active ingredient per gallon) per surface acre to foliage.

Alternative Control Method: Granular Silvex: 20 to 30 pounds active Silvex per surface acre.

TIPS FROM THE EXPERTS
Seeds may sink to the bottom and remain dormant for years. Re-infestation may thus occur years after chemical eradication.

WATER HYACINTH [*Eichhornia crassipes*]

Description: Plants free-floating or rooted in mud. Leaves large and broadly lance-like extending from inflated stalk. Flowers blue violet or white. Roots dark and fibrous. Plants reproduce by fragmentation or by seeds.

Distribution: Common in tropical and subtropical areas of the United States (Florida, Texas and gulf coast region).

Similar Species: FROGBIT [*Limnobium spongia*]

Description: Often confused with Water Hyacinth. Leaves and roots extend from the floating rhizome in a rosette. The flowers are white and less showy than hyacinth.

Distribution: Found along the east coast from Ontario to Florida and along gulf coast into Texas. Commonly occupies stagnant water in ponds, lakes and marshes. Ranges northward farther than hyacinth.

Recommended Control Method: Apply 1 gallon of 2, 4-D (dimethylamine salt, 4 pounds active) per surface acre to foliage.

Alternative Control Method: Diquat: 1 to 1.5 quarts of Diquat per surface acre.

THE COMMERCIAL APPLICATOR

Up to this point we have been concerned principally with those people who want to improve the water quality of their ponds, lagoons or lake frontages through their own efforts. The instructions and weed identification photos were provided to assist the individual who wanted to develop his own aquatic nuisance control program.

Now a bit of information for those who, for one reason or another, would prefer to leave water management to the experts. Obviously, there are limitations to the scope of operations that can be handled by one person. As indicated earlier, the most successful water quality improvement programs are usually planned by lake associations, municipalities or sanitary districts who employ a firm of professional applicators to handle the entire job. By so doing, they avoid personal responsibility and achieve predictable, planned results in water improvement.

A commercial applicator can provide some or all of the following services:

1. Water management
2. Chemical weed and algae treatment
3. Weed cutting
4. Rough fish control
5. Dredging
6. Environmental impact reports
7. Lake rehabilitation and feasibility studies
8. Fish management

Should you employ a commercial applicator? Perhaps. An experienced aquatic applicator can begin a professional program of water rehabilitation that will eventually revive your weed-choked lake or pond. The resulting improvement in water quality can restore desirable recreational activities—swimming, boating, sailing, skiing, fishing—and upgrade your property values. Along with this, a long-term program of permanent lake rehabilitation should be planned and implemented.

Many of the water improvement suggestions in this book evolved from the actual experiences of the biologists employed by Marine Biochemists, Inc., professional applicators and field staff consultants to Applied Biochemists, Inc. This same consulting service is available to you anywhere in the country to help solve your water management problems. We'll be happy to send a biologist (for a reasonable consulting fee) to see your problem personally and suggest remedies. Simply phone (414) 242-0450 and ask to speak to a Marine biologist. We'll even recommend a professional applicator in your area if one is available.

So clean up your waters, America! We're ready to help!

GENERAL RESTRICTIONS ON USE OF TREATED WATER

Number of Days

COMMON NAME	CHEMICAL NAME	AMOUNT OF ACTIVE INGREDIENT	HUMAN			ANIMAL	IRRIGATION		
			DRINKING	SWIMMING	FISH CONSUMPTION	DRINKING	TURF	FOOD CROPS	FORAGE
Cutrine-Plus Liquid	Copper Alkanolamine Complex	9%	0	0	0	0	0	0	0
Cutrine-Plus Granular	Copper Alkanolamine Complex	3.7%	0	0	0	0	0	0	0
Dalapon	2,2-dichloropropionic Acid	85%	**	**	**	**	**	**	**
Dichlobenil	2,6-dichlorobenzonitrile	10.0%	*	*	90	*	*	*	*
2,4-D Liquid Ester	2,4-dichlorophenoxyacetic acid	4 lbs. per gallon	*	1	3	*	3	*	*
2,4-D Granular Ester	2,4,5-trichlorophenoxyacetic acid	20% per pound	*	1	3	*	3	*	*
Diquat	1:1-ethylene-2:2-dipyridylium dibromide	2 lbs. of cation per gallon	10	10	10	10	10	10	10
Endothall Granular	Dipotassium salt of endothall	10.1%	7	1	3	7	7	7	7
Endothall-Silvex *** Combination-Liquid	Dipotassium salt of endothall & Potassium salt of silvex	22.1% 25.3%	*	2	3	*	*	*	*
Endothall-Silvex *** Combination-Granular	Dipotassium salt of endothall & Potassium salt of silvex	5.1% 5.6%	*	2	3	*	*	*	*
Hydrothol 47 Granular	di [N,N dimethylalkylamine] salt of endothall	17.5%	14	2	14	14	14	14	14
Potassium endothall	Dipotassium salt of endothall	4.23 lbs. per gallon	7	1	3	7	7	7	7
Silvex ***	2[2,4,5-trichlorophenoxy] propionic acid	4 lbs. acid per gallon	*	2	3	*	*	*	*
Weedtrine-D	1:1-ethylene-2:2-dipyridylium dibromide	8.53%	10	10	10	10	10	10	10
Weedtrine II	2,4-dichlorophenoxyacetic acid Iso-octyl Ester	30.22%	*	1	3	*	3	*	*

* In cases where restrictions are not given in above chart, consult your State Conservation Commission or Fish & Game Department for specific restrictions Chemical manufacturers and manufacturer's representatives can also supply you with specific recommendations based on water usage

** Care should be taken to prevent contamination of water. Presently no approval for aquatic use is contained on the maufacturer's label

*** Silvex now banned in many States, check with your local authorities.

POST-TREATMENT

Questions & Answers

When will I see results?
Usually, plants begin to show signs of weakness or die within two weeks. Signs include discoloration, elongation, or drooping. Filamentous algae often turns pale yellow or white. Dead plants with tough stems and sturdy root systems may remain standing until wind or waves break them up.

What happens to the dead plant material?
Decaying weeds and algae usually sink to the bottom after they die. Occasionally, however, plants with weak stems may break loose and remain floating for a short period of time. Microscopic organisms in the water break down plant materials into more basic components leaving a fine silt which settles to the bottom.

Will my water quality change?
When large masses of plant materials decay, the nutrients are released. This will sometimes result in a rapid growth of planktonic or filamentous algae. This growth can be treated with CUTRINE-PLUS.

How long will control last?
Most weed species can be controlled for an entire season with a properly timed, single treatment. Herbicides do not kill seeds, nor do they get into the root systems of some plants. This can result in a regrowth of the plants later in the season. A touch-up treatment is usually all that is necessary to get rid of these.

Algae will generally require several treatments per season because of their ability to reproduce rapidly. Regrowths generally occur 4-6 weeks apart.

Will I have less plants next year?
Weeds and algae are a continuing problem from year to year in the same body of water. Weed beds might be reduced the following year if they were treated before seeds developed. However, this is rare. Bodies of water are continually changing. Consequently, dominant weed species may also change, and a different herbicide might be required for the new species. Weather factors may also enhance or inhibit the growth of a particular weed in different years.

Do resistant plants establish themselves?
There is some evidence that treating too often, year after year with the same chemicals, may result in the establishment of a weed or algae growth that is very difficult to control. Usually, choosing an alternative chemical will provide effective control.

What happens to the chemical that is put into the water?
Most approved aquatic chemicals do not remain in the water in their original state for extended periods of time. Chemical and biological action break down (biodegrade) these compounds into simpler substances and they are recycled into the environment.

What are common reasons for failure?
Failures are generally less than 10%, but when they occur, it may be for one or more of the following reasons:

1. Not reading the label and following directions.
2. Mis-identification of the weed.
3. Mis-calculation of treatment area resulting in wrong dosage.
4. Adverse weather conditions (high winds, rainstorms) during and following treatment.
5. Water conditions (high turbidity, low temperatures, etc.) can chemically or physically interfere with herbicidal action.
6. Weed regrowth or appearance of new weed.
7. Improper timing of treatment—too late or too early.
8. Rapid water exchange causing chemical dilution.

CONCLUSION

We have tried to point out that water management and lake rehabilitation are everyone's concern. At this point in time, we have really only touched the tip of the iceberg. As population and water uses increase, the problems of water pollution and degradation increase proportionally.

Improvement and maintenance of water quality must become an ongoing activity similar to yard maintenance. This can be done individually or more successfully as a group or lake association project. In some areas, cost-sharing funds for lake rehabilitation are available from the State or Federal government. Successful lake improvement projects have been handled on a county-wide basis. Municipalities and sanitary districts have formed the basis for effective aquatic nuisance control.

However it is planned or implemented, the important thing is to do something. Recreational or functional waters need not choke up and die. This trend toward eutrophication (water deterioration) can be checked. All it requires is a common-sense approach to the problem by everyone concerned.

Perhaps your own property can be enhanced considerably with the addition of a man-made pond for fishing, swimming, and boating. It's really not that difficult. Digging often uncovers natural springs that will help to keep your waters fresh and pure. Your state or federal Soil Conservation Service will be glad to offer their skilled help in planning and constructing your water body. There's nothing quite like having your own private fishing pond for hours of happy recreation for the entire family.

This book has attempted to assist you in tackling the problem. Applied Biochemists, Inc., whose main purpose is water quality improvement, will continue their laboratory search for newer, safer, more effective algaecides and herbicides to protect the environment and enhance water quality. This expertise is available to you. Use the form on page 63 or phone us. We'll be happy to help you.

AREA IN ACRES

WIDTH	LENGTH — Feet																			
Feet	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000
100	230	344	459	574	689	803	918	1.03	1.15	1.26	1.38	1.49	1.61	1.72	1.84	1.95	2.07	2.18	2.30
150	344	517	689	861	1.03	1.21	1.38	1.43	1.72	1.89	2.07	2.24	2.41	2.58	2.75	2.93	3.10	3.27	3.44
200	459	689	918	1.15	1.38	1.61	1.84	2.07	2.30	2.53	2.75	2.98	3.21	3.44	3.67	3.90	4.13	4.36	4.59
250	574	861	1.15	1.43	1.72	2.01	2.30	2.58	2.87	3.16	3.44	3.73	4.02	4.30	4.59	4.88	5.17	5.45	5.74
300	689	1.03	1.38	1.72	2.07	2.41	2.75	3.10	3.44	3.79	4.13	4.48	4.82	5.17	5.51	5.85	6.20	6.54	6.89
350	803	1.21	1.61	2.01	2.41	2.81	3.21	3.62	4.02	4.49	4.82	5.22	5.62	6.03	6.43	6.83	7.23	7.63	8.03
400	918	1.38	1.84	2.30	2.75	3.21	3.67	4.13	4.59	5.05	5.51	5.97	6.43	6.89	7.35	7.81	8.26	8.72	9.18
450	1.03	1.43	2.07	2.58	3.10	3.62	4.13	4.65	5.17	5.68	6.20	6.71	7.12	7.75	8.26	8.78	9.30	9.81	10.3
500	1.15	1.72	2.30	2.87	3.44	4.02	4.59	5.17	5.74	6.31	6.89	7.46	8.03	8.61	9.18	9.76	10.3	10.9	11.5
550	1.26	1.89	2.53	3.16	3.79	4.42	5.05	5.68	6.31	6.94	7.58	8.21	8.84	9.47	10.1	10.7	11.4	12.0	12.6
600	1.38	2.07	2.75	3.44	4.13	4.82	5.51	6.20	6.89	7.58	8.26	8.95	9.64	10.3	11.0	11.7	12.4	13.1	13.8
650	1.49	2.24	2.98	3.73	4.48	5.22	5.97	6.71	7.46	8.21	8.95	9.70	10.4	11.2	11.9	12.7	13.4	14.2	14.9
700	1.61	2.41	3.21	4.02	4.82	5.62	6.43	7.12	8.03	8.84	9.64	10.4	11.2	12.0	12.9	13.7	14.5	15.3	16.1
750	1.72	2.58	3.44	4.30	5.17	6.03	6.89	7.75	8.61	9.47	10.3	11.2	12.0	12.9	13.8	14.6	15.5	16.4	17.2
800	1.84	2.75	3.67	4.59	5.51	6.43	7.35	8.26	9.18	10.1	11.0	11.9	12.9	13.8	14.7	15.6	16.5	17.4	18.4
850	1.95	2.93	3.90	4.88	5.85	6.83	7.8[illegible]	8.78	9.76	10.7	11.7	12.7	13.7	14.6	15.6	16.5	17.6	18.5	19.5
900	2.07	3.10	4.13	5.17	6.20	7.23	8.26	9.30	10.3	11.4	12.4	13.4	14.5	15.5	16.5	17.6	18.6	19.6	20.7
950	2.18	3.27	4.36	5.45	6.54	7.63	8.72	9.81	10.9	12.0	13.1	14.2	15.3	16.4	17.4	18.5	19.6	20.7	21.8
1000	2.30	3.44	4.59	5.74	6.89	8.03	9.18	10.3	11.5	12.6	13.8	14.9	16.1	17.2	18.4	19.5	20.7	21.8	23.0

CUT ON DOTTED LINE

CLEAN WATER CONSULTATION

ALGAECIDES AND HERBICIDES FOR LAKES, PONDS AND RESERVOIRS

The following data will enable us to evaluate and pinpoint your aquatic nuisance problems and make recommendations for their control. Please fill in as many blanks as you can and be as specific as possible, particularly as to the type of weeds and algae present.

Your Name _____ Telephone _____

Address _____

City _____ State _____ Zip Code _____

Name and Location of Lake _____

_____ Size (acres) _____

Committee Members	Telephone

1. PROBLEMS

Please describe type of weed and algae growth

_____

_____

_____

2. WATER USES

Swimming ___ Boating ___ Fishing ___ Water Supply ___

Other _____

Fish Varieties _____

3. CHARACTERISTICS OF LAKE

Water temp. (approx.) _____ °F Hardness _____

4. PRIOR TREATMENT

Chemicals Used

A. Type and Price _____

B. Frequency of Application _____

C. Annual Budget for Chemicals _____

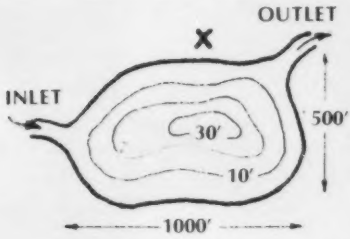
D. Quantities Used _____

E. Name of Applicating Company _____

Please Complete Back of Form 63

SKETCH OF LAKE

SAMPLE SKETCH



CHECK LIST

PLEASE BE SURE YOUR SKETCH BELOW SHOWS

Scale Used _____

Length of Lake _____ ft.

Width of Lake _____ ft.

Depth: Avg. _____ ft.

Max. _____ ft.

SKETCH SHOULD ALSO SHOW:

Depth Contours

Inlets

Springs

location of weeds/algae

YOUR SKETCH

Note; We will analyze aquatic weed samples sent with this form and suggest remedy. Pack weeds or algae in damp paper towel and seal in plastic sandwich bag. Fee is $5.00 sent with sample. Fee refunded with spray contract or chemical purchase. Send to: Applied Biochemists, Inc. P.O. Box 25, Mequon, WI 53092